

TM 9-1950

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ROCKETS



HEADQUARTERS, DEPARTMENT OF THE ARMY
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TECHNICAL MANUAL

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ROCKETS

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* This manual supersedes TM 9-1950, 17 July 1950, including C 1, 7 May 1953; and C 2, 29 September 1953.

CHAPTER 1

GENERAL

Section I. INTRODUCTION

1. Scope

a. This manual describes military rockets (fig. 1) having solid propellants. It contains technical information necessary for their identification, care, handling, preservation, use, and destruction.

b. The appendix contains a list of current references, including supply and technical manuals, and other available publications applicable to the rockets.

c. This manual differs from TM 9-1950, 17 July 1950; C 1, 7 May 1953; and C 2, 29 September 1953, as follows:

- (1) Adds information on—
 - 27-mm subcaliber rocket.
 - 2.0-inch aircraft rockets.
 - 2.75-inch aircraft rockets.
 - 3.5-inch rocket M35.
 - 3.5-inch rocket M35A1.
 - 3.5-inch rocket M36.
 - 4.5-inch rocket M32.
 - 4.5-inch rocket M33.
 - 4.5-inch rocket T164E1.
 - BD, SD rocket fuze M409.
 - Dummy rocket fuze M405.
 - Dummy rocket fuze M410.
 - BD rocket fuze M404A2.
 - PI, BD fuze M408.
 - PI, BD fuze M408E1.
 - Dummy fuze M73.
 - Nose rocket fuze Mk 154 Mods 0, 2, and 3.
- (2) Deletes information on—
 - 2.36-inch rockets.
 - 3.25-inch rockets.
 - 3.5-inch rocket HE M28A1.
 - 3.5-inch rocket practice M29.
 - 3.5-inch aircraft rockets.
 - 4.5-inch rocket folding fin type.

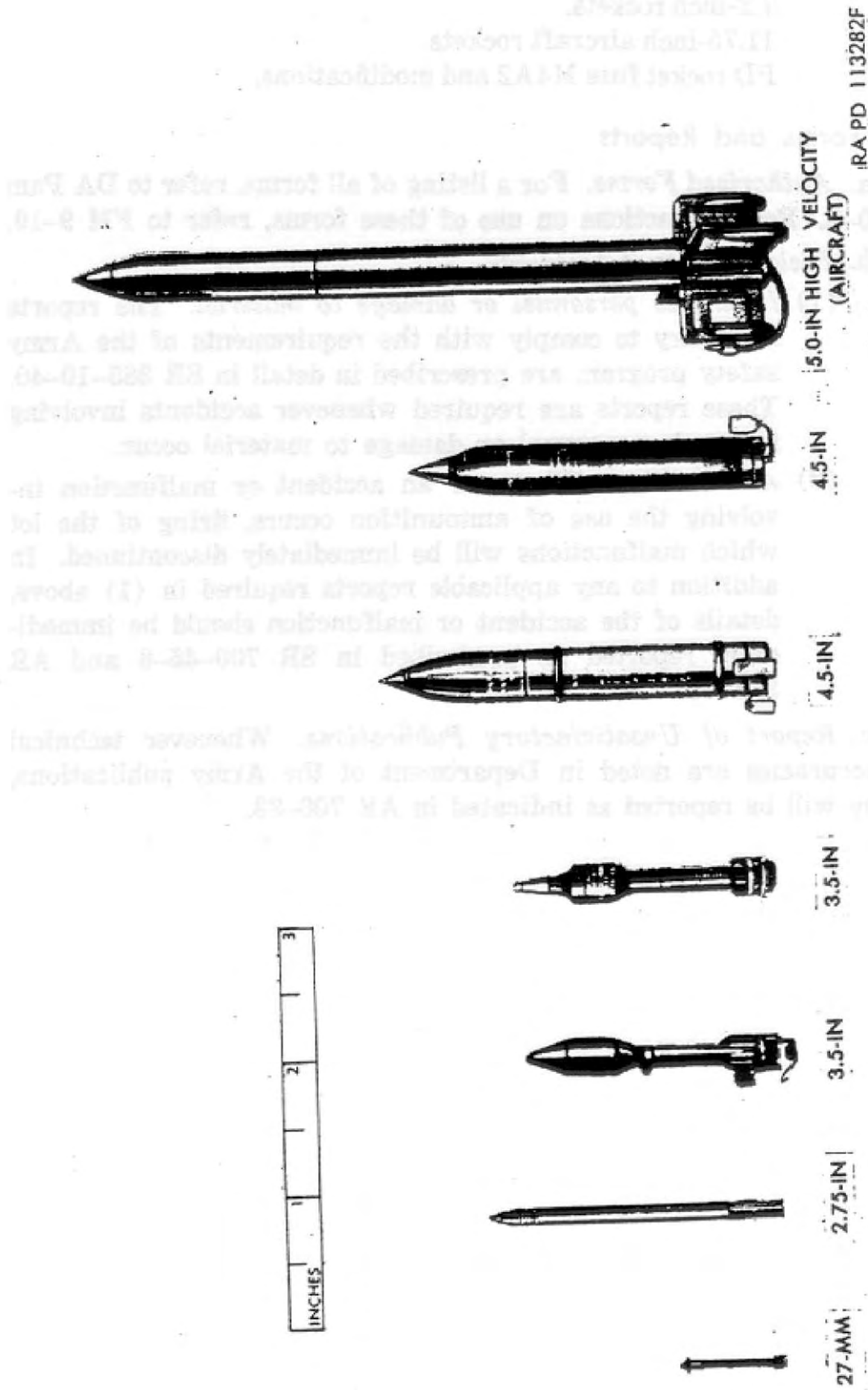


Figure 1. Representative types of rockets.

4.5-inch beach barrage rocket.
7.2-inch rockets.
11.75-inch aircraft rockets.
PD rocket fuze M4A2 and modifications.

2. Forms and Reports

a. Authorized Forms. For a listing of all forms, refer to DA Pam 310-2. For instructions on use of these forms, refer to FM 9-10.

b. Field Reports of Accidents.

- (1) *Injury to personnel or damage to materiel.* The reports necessary to comply with the requirements of the Army safety program are prescribed in detail in SR 385-10-40. These reports are required whenever accidents involving **injury to personnel or damage to materiel** occur.
- (2) *Ammunition.* Whenever an accident or malfunction involving the use of ammunition occurs, firing of the lot which malfunctions will be immediately discontinued. In addition to any applicable reports required in (1) above, details of the accident or malfunction should be immediately reported as prescribed in SR 700-45-6 and AR 385-63.

c. Report of Unsatisfactory Publications. Whenever technical inaccuracies are noted in Department of the Army publications, they will be reported as indicated in AR 700-38.

Section II. GENERAL DISCUSSION

3. Rocket Terminology

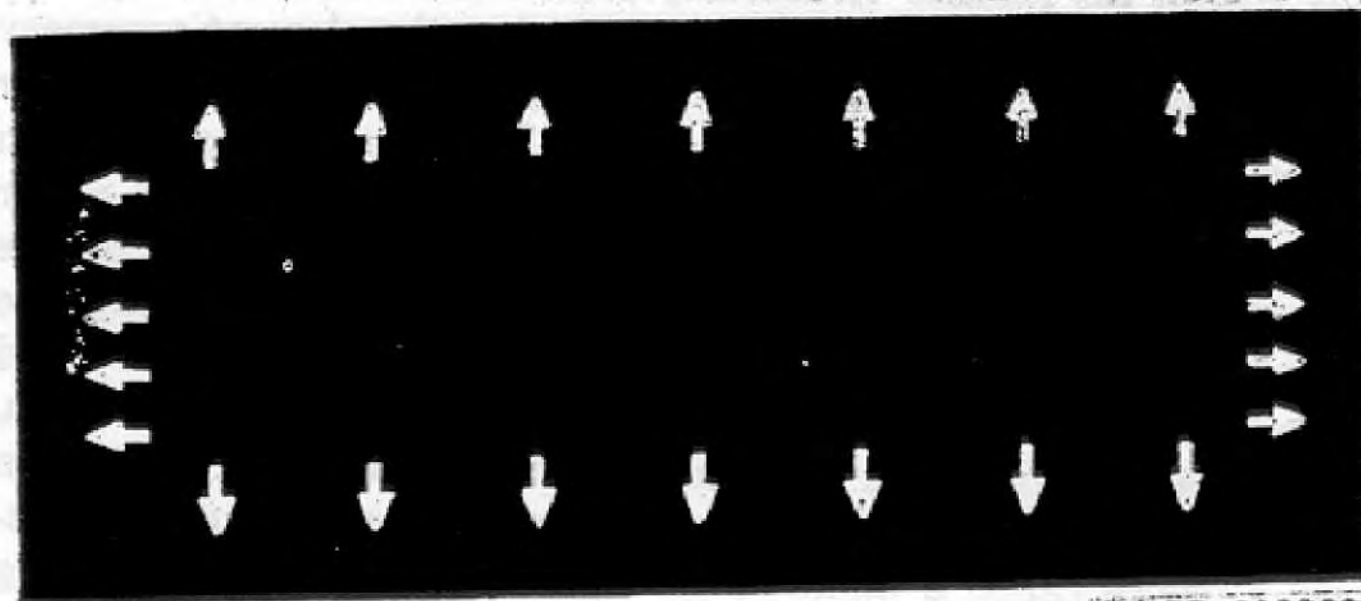
A rocket (fig. 1) is a missile which is propelled by the reaction of a discharging jet of gas from the burning of a charge of propellant within the rocket. A military rocket consists essentially of a head, fuze, and a motor. The head comprises the element necessary to produce the desired effect at the target, usually an explosive or chemical filler. The fuze provides means of initiating the explosion of the head at the time and circumstances desired. The motor comprises the elements necessary to propel the rocket, including the propellant charge, nozzle or nozzles, and means of igniting the propellant. Stabilization is accomplished either by fins attached to the motor (fin type) or, in the case of multiple nozzle rockets, by so locating the nozzle that the rocket is rotated in flight (spin type). In order that a rocket may be launched on a definite trajectory, a device called a launcher is required. Aside from providing means for initiating ignition of the rocket propellant, the launcher is required only to aim the rocket. Consequently, rocket launchers may be so light and portable that rockets can be fired from airplanes and from ground areas inaccessible to conventional artillery. The employment of rocketry is more economical than that of artillery against light and, in some instances, heavy targets at relatively short ranges. A further advantage of the use of rockets lies in the fact that the forces of setback are relatively small but spread over a comparatively long period of acceleration, thus permitting the use of light-case projectiles of higher capacity and less expensive construction than artillery shell of similar caliber, and the use of fuzes of less rugged construction. A rocket is relatively inexpensive, easily launched, and economical as to use of personnel. A disadvantage of rockets, as compared with conventional artillery rounds, is that operating personnel and flammable material must be protected from the rearward blast of hot gas, fragments of propellant, wiring, and nozzle closures.

4. The Rocket Principle

The basic principle of rocket propulsion may be described and illustrated as follows:

a. When a gas is compressed in a closed vessel, pressure is transmitted equally in all directions (Pascal's law); hence, the force in one direction is counterbalanced by an equal force in the opposite direction with no resulting motion of the closed vessel. This is illustrated diagrammatically by arrows in figure 2 representing a closed tube. Note that although the equal and opposite forces on

the side walls of the tube are represented in figures 2, they are omitted in figures 3 and 4 because they cancel each other and therefore are not necessary in the further discussion of the rocket principle.



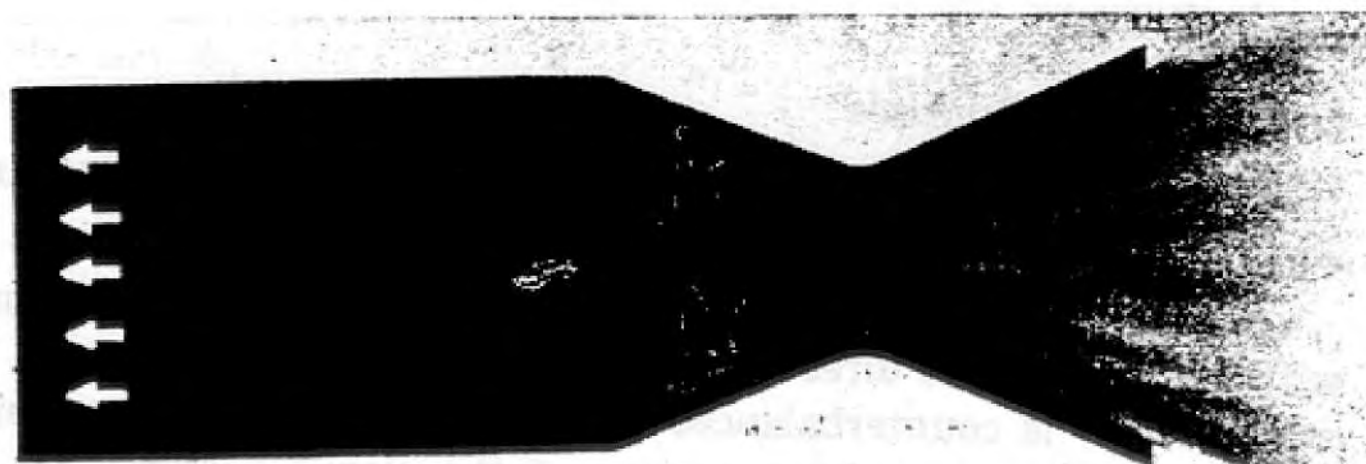
RA PD 113283

Figure 2. Rocket principle (pressure in closed tube).



RA PD 113284

Figure 3. Rocket principle (movement of tube-opening in one end).



RA PD 113285

Figure 4. Rocket principle (movement of tube-nozzle in one end).

b. When an opening to the atmosphere is made in one end of the tube (fig. 3), the pressure at the opening drops to near atmospheric while the pressure on the closed end remains momentarily greater than atmospheric; as a consequence, the tube tends to move in the direction of the closed end while a stream or jet of gas is ejected from the open end. During the time that gas is being generated within the tube, as by the burning of a propellant, high wall pressure is maintained at the closed end while near-atmospheric pressure prevails at the opening. Thus, the high pressure at the closed end, acting on a wall area equal to the area of the opening, results in a force or thrust in the direction of the closed end. For relatively small openings, as in the case of an actual rocket motor, the wall pressure at the open end may be considered substantially the same as that at the closed end, except at the actual opening where the pressure is atmospheric. Hence, the *forces* at the closed and open ends are practically equal except on the area of the opening. At the opening, this force is zero whereas at the closed end it is equal to the pressure times an area equal to the area of the opening. The forces causing motion in the direction of the closed end while the propellant is burning are represented diagrammatically in figure 3. Thus, burning of a propellant in a tube, closed at one end and with an opening in the other end, results in the utilization of heat energy through the production of gas pressure which by reaction, tends to move the tube as gas escapes through the opening.

c. Gas passing by the square corners near and at the opening (fig. 3), would be subject to substantial frictional losses due to turbulence which is represented by the curlicues in the shading near the opening. These losses are largely overcome by using the shape shown in figure 4, forming a nozzle. This type of opening has a smooth contour which provides for a nonturbulent, hence relatively frictionless, flow of gas represented by the smoothness of the shading. The constricted opening, called the throat, limits the flow of gas and thereby maintains pressure within the tube while the propellant is burning. The gas, while flowing through the nozzle, is still under a pressure which decreases from the throat to the open end of the nozzle. Referring to figure 4, forces, such as (c) and (c') resulting from pressure on the approach side of the nozzle are substantially the same magnitude as (may be slightly less due to somewhat lower pressure at the nozzle end) but in the opposite direction to those on an equivalent area at the closed end; hence, they balance each other. Since force components represented by (b) and (e) are equal and opposite to (b') and (e') they have no effect on motion. Pressures represented by (d) and (d') normal to the wall of the nozzle result in force components (f) and (f') in the direction of flight. Hence, energy which otherwise would be lost, if the gas

were discharged through an opening such as that in figure 3, is converted to additional thrust by use of the nozzle. Thus, the principle forces producing motion of the tube consist of those resulting from the internal pressure acting at the closed end on an area equivalent to that of the throat, plus the axial forces (f) and (f') resulting from the pressure within the nozzle.

5. Classification

a. *Use.* Rockets are classified according to use as ground or aircraft.

b. *Purpose.* Rockets are classified according to purpose as service, practice, drill, or subcaliber. Service rockets are used for effect in combat; practice rockets are used for training and target practice; drill rockets are used for training and handling; subcaliber rockets are smaller rockets designed for practice purposes and for reasons of economy, and are fired from standard launchers with the aid of a **subcaliber launcher** inserted in the bore.

c. *Filler.* Rockets are classified according to the filler as high-explosive, chemical, and inert.

(1) High-explosive rockets contain a filler of high-explosive for blast, fragmentation, mining, or demolition effect. The high-explosive antitank (HE, AT) rocket, which contains a filler consisting of a shaped charge of composition B or other high-explosive, is used for penetration of armored targets. (The designation HE, AT identifies ammunition **utilizing the shaped charge principle.**)

(2) Chemical rockets contain a chemical agent and a burster or an igniter to disperse or ignite the agent at the target. The chemical agent may be a gas for producing a toxic or harassing effect, a smoke producer for screening or signaling, an incendiary, or a combination of these.

(3) The head of rockets which are intended for target practice are completely inert and fuzed with inert (dummy) fuzes; the motor contains the same propelling charge and igniter as the service rocket. Drill rockets, intended for training in service of the piece, are completely inert—both head and motor.

6. Identification

a. *General.* Rockets, in common with other types of ammunition, are identified by the standard nomenclature and a lot number of the item. Such identification is marked on all containers and, unless the item is too small, on the ammunition itself.

b. *Lot Number.* When ammunition is manufactured, a lot num-

ber is assigned in accordance with pertinent specifications. A "lot" consists of a number of items, manufactured from similar materials under similar condition which may be expected to function alike. The lot number consists, in general, of the loader's initial or symbol, and the number of the lot. The ammunition lot system for rockets provides a means by which an adequate record may be maintained at the components assembled into this type ammunition. The ammunition lot serves as a unit by which defective components may be withdrawn from use or restricted from issue. In addition, the ammunition lot is used for control purposes in recording, storing, and shipping ammunition.

c. Model. To identify a particular design, a model designation is assigned at the time the model is classified as an adopted type. This model designation becomes an essential part of the nomenclature and is included in the marking on the item. The present system of model designation consists of the letter "M" followed by an Arabic numeral; for example "M28." Modifications are indicated by adding the letter "A" and the appropriate Arabic numeral. Thus, "M28A1" indicates the first modification of an item for which the original model designation was "M28." Whenever a "B" suffix appears in a model designation it indicates an item of alternative (or substitute) design, material, or manufacture. Certain items standardized for use by both Army and Navy are designated by "AN" preceding the model. Development items are indicated by letter "T" and an Arabic numeral and modification by the addition of "E" and an Arabic numeral. Designations of items of Navy design consist of the word "mark" (Mk), followed by an Arabic numeral, together with a modification (Mod) number, thus: Mk 6 Mod 2.

d. Painting. Service ammunition is painted with lusterless paint to prevent rust and to camouflage it, and in various colors to provide means of identification. In general, rocket motors are painted olive drab. The colors used for painting rocket heads are as follows:

	Army	Navy
High-explosive.....	Olive drab; marking in yellow.	Olive drab; marking in white.
Chemical (casualty gas).	Gray; band and marking in green.	Gray; green band, lettering in white.
Chemical (smoke).....	Gray; band and marking in yellow.	Gray; yellow band, lettering in white.
Practice.....	Blue; marking in white.	Blue; marking in white.
Drill (inert).....	Black; marking in white.	Black; marking in white.

e. Marking. Ammunition items are marked, by stamping in the metal or by stenciling, with the type, size, model, and lot number.

The safe temperature limits for storage and use is shown on the rocket motor.

f. Data Card. A 5- by 8-inch card for each lot is supplied with each shipment of ammunition. This card gives the ammunition lot number of the items, the lot number of each component of the item, and other pertinent data such as muzzle velocity, Federal stock number and Department of Defense Identification Code, and assembling and firing instruction when required.

g. Federal Stock Number and Department of Defense Identification Code. These are used to facilitate the supply of ammunition in the field. The Federal stock number (FSN) is an 11-digit number consisting of a 4-digit Federal supply class (FSC) number and a 7-digit Federal item identification number (FIIN). The Department of Defense Identification Code (DODIC) is a four-place (one letter and three digits) code. A Federal item identification number (FIIN) is assigned to each ammunition item in a specific packing. When requisitioning ammunition, a combination of the Federal supply class (FSC) number and the Department of Defense Identification Code (DODIC) may be used, in which case the requisitioner will receive the ammunition or any authorized substitute in any authorized packing. If a specific item in a specific packing is required, the requisitioner must make a justification therefor and use the complete Federal stock number (FSN) together with the Department of Defense Identification Code (DODIC).

7. Complete Round

a. General. The complete round consists of all the components of the rocket necessary to fire one round. The complete round may be issued as a single assembled unit or as separate components to be assembled in the field. The separate components are described below.

- (1) The motor which propels the rockets contain the propelling charge and the igniter and is assembled to the rear of the head or base detonating fuze. It consists of a tube closed at the forward end and having one or more nozzles at the rear end. The propelling charge in stick form is held in place by a trap, grid, or cage. Provision is made in the form of contact rings, fixed connections to fin shrouds, or cable and plug, dependent upon the design of the launcher, for electrically connecting the igniter to the external firing circuit. Details are described in the sections pertaining to specific rockets.

- (2) The rocket head is that component which contains the

high-explosive charge or other filler, the booster, and the fuze. Its purpose is to produce the desired effect at the target.

b. Explosive Train. The large quantities of explosives in rocket heads and motors must be comparatively insensitive to permit safe handling in storage and transit. Yet, dependable means of initiating these explosives at the desired time must be available. These requirements give rise to the high-explosive train in the rocket head and the propellant explosive train in the rocket motor.

(1) *High-explosive train.* Sensitive explosives that can be detonated by the impact of a firing pin or by electrical means are safe to handle when they are in small quantities, highly compressed and enclosed in a capsule. They are used in that form in fuze primers, detonators, and squibs. Since the small flame from a primer, detonator, or squib will not properly detonate a large charge of comparatively insensitive explosive, it is necessary to interpose a medium quantity of explosive of medium sensitivity. Such an arrangement of explosives is called a high-explosive train. This train, which is in the rocket head, consists essentially of a primer, detonator, or squib, a booster, and the high-explosive charge. A delay element sometimes is incorporated in the fuze to meet requirements for delay action.

(2) *Propellant explosive train.* Sensitive explosives that can be detonated by electrical means are safe to handle when in small quantities, highly compressed and enclosed in a capsule. They are used in that form in electric squibs. Since the small spit of flame from an electric squib will not properly ignite a large charge of comparatively insensitive propellant, it is necessary to interpose a medium quantity of explosive of medium sensitivity. Such an arrangement of explosive is called a propellant explosive train. This train, which is in the rocket motor, consists essentially of an electric squib, igniter black powder charge, and the propellant charge.

8. Head

a. High-Explosive. Some high-explosive rocket heads are of thin-walled construction for maximum capacity of explosive and blast effect; some have heavy walls to permit penetration of light armor before exploding; and others have walls of medium thickness to provide a maximum number of effective fragments. High-explosive rocket heads are designed for use with point fuzes, base fuzes, or both.

b. *High-Explosive Antitank (HE, AT)*. Heads of these rockets are of special shape and contain a shaped charge for penetration of armored or other resistant targets. They are designed for use with inertia type base detonating fuzes or with point initiating base detonating fuzes to achieve faster fuze functioning thereby increasing overall efficiency of the shaped charge head.

c. *Chemical*. Chemical rocket heads usually are of thin-walled construction. They may be designed for a point fuze or a base fuze and have a burster well extending along the axis of the head from the fuze seat. Chemical rocket heads may be loaded with casualty or harassing gas, or smoke.

d. *Practice*. Practice rocket heads are inert, and match the weight of the high-explosive heads. They consist either of the high-explosive head metal parts loaded with inert material or of hollow metal heads specially designed to have the same weight. They may have an inert or dummy fuze or no fuze.

9. Fuze

a. A fuze is a device used with an item of ammunition to cause it to function at the time and under the circumstances desired.

b. Rocket fuzes are classified according to location in the head as PD (point detonating) (the Navy term is "nose") or BD (base detonating). Fuzes are classified according to functioning as time, VT (proximity), PI (point initiating), or impact. Fuzes are classified also according to a combination of location and functioning as PI, BD (point initiating, base detonating). Time fuzes function a preselected number of seconds after the round is fired. Impact fuzes function upon impact with superquick, nondelay, or delay action. In the case of superquick action, the shell functions practically instantaneously on impact, initiated by a firing pin driven into a detonator. Nondelay action occurs in impact fuzes initiated by inertia-driven firing pins or detonators, being only slightly slower than superquick action. In delay action fuzes, the shell functions a fixed time after impact (the amount of delay, usually between 0.025 and 0.15 second, is dependent upon the delay element incorporated in the fuze) to permit penetration of the target before the shell explodes. Arming may be accomplished by mechanical means utilizing gear trains, air stream (air arming), spring action, centrifugal force or inertia, gas pressure (pressure arming), or a combination thereof.

c. The VT fuze detonates the rocket head at a distance from the target to produce optimum blast effect. It is essentially a radio transmitting and receiving unit and requires no prior setting or adjustment. Upon firing, after elapse of the minimum arming

time, the fuze arms and continually emits radio waves which, as the rocket approaches the target, are reflected back to the fuze. The reflected waves produce a "beat" which, when received by the fuze with a predetermined intensity, as on approaching close to the target, operates an electronic switch in the fuze. This permits electric current to flow through an electric squib, initiating the explosive train and detonating the rocket. VT fuzes are of two types—one for ground type rockets, the other for aircraft type rockets. VT fuzes are physically interchangeable with other standard fuzes in ground type rockets having deep fuze cavities.

Caution: Rockets fuzed with VT fuzes may function prematurely if fired too close to trees or other intervening objects. There should be at least 250 feet clearance from objects short of the target.

d. The PIBD fuze detonates the rocket on impact with the target. The fuze consists of a nose assembly and a base assembly connected by a wire passing through a conduit in the rocket head. The pressure of impact on a piezoelectric crystal in the nose assembly generates a minute surge of electricity which is transmitted to a low energy detonator in the base assembly, detonating it. If the impact is insufficient to actuate the piezoelectric crystal, a spring-loaded firing pin in the base functions the fuze.

e. Boresafe rocket fuzes are those in which the explosive elements are separated in such a manner that explosion of the rocket head before the rocket leaves its launcher is prevented, even if the more sensitive elements (primer or detonator) should accidentally function.

10. Motor

a. A rocket motor is that component which propels the rocket and is assembled to the rear of the head or of a base detonating fuze. It consists of a steel tube which is closed at the forward end by its attachment to the head or base detonating fuze. In some types, the tube is constricted at the rear end to form the throat of a single nozzle. In other types, there are several nozzles located in the base. The motor contains the propelling charge, the propelling charge support, and the igniter. The flight of the rocket is stabilized by fins attached to the rear of the motor, or by the rotation of a rocket about its axis, called spin. This spin is produced by the reaction of the gas passing at high velocity through the base nozzles, the axis of which are at an angle but not in the same plane as the axis of the motor. The openings in the motor are sealed for protection against the entrance of dirt and moisture by closures (fiber, metal, plastic, or other type disks) which are blown out when the rocket is fired.

b. The igniter consists of a charge of black powder and an electric squib in a plastic or metal container. In general, the squib lead wires emerge from the igniter and are connected to contact points or rings on the outer surface of the rocket which engage the launching contacts when the rocket is chambered in the launcher. In some types of rockets, the lead wires are connected to fin shrouds or to a standard electric plug.

c. The propelling charge in rockets generally consists of a double-base propellant. In recent years, new propellant formulations, such as perchlorate and nitrate composites, have been extensively used. The charge may be formed into a single large grain or a number of smaller grains and held in place by a cage-like support (trap assembly) (fig. 65) or by suspension on screws. The weight of the propelling charge is generally adjusted for each lot of propellant to give uniform flight characteristics. See chapter 4 for detailed discussion.

d. The burning rate of propellant varies with its initial temperature and burning surface area. The higher the initial temperature or burning surface area the faster the propellant burns. When rockets are fired at initial temperatures higher than those for which they are specified, the higher pressure built up in the motor causes longer than normal, and hence erratic, ranges. If rockets are handled roughly at low temperatures, the propellant may crack creating more burning surface causing higher pressure to build up in the motor and erratic ranges. In extreme cases, the motor may detonate. When rockets are fired at temperatures below those specified, the propellant burns slower causing shorter than normal, and hence erratic, ranges and longer "afterburning."

11. Launchers

a. *General.* The rocket launcher serves to hold and aim the rocket, to provide electric contacts for firing, and, in some cases, to protect the operator against the blast of the rocket. In some launchers the source of electricity for ignition is integral with the launcher as a magneto or batteries; in other launchers, electrical energy is derived from an outside source such as an aircraft's electrical system.

b. *Tube Type Launchers.* The launcher proper, as distinct from the mount, consists of a tube or a set of tubes with a means of holding the rocket in place and a system of electrical contacts. There is no recoil since the propulsion of the rocket is accomplished by the jet action of the propellant in the motor tube of the rocket and does not depend upon gas pressure built up inside the launcher tube. Therefore, the launcher tube need be only heavy enough to

prevent denting or bending during handling and to prevent excessive heating at normal rates of fire. Some launchers are expendable (*f* below); that is, they are used for only one firing or a rocket. In some cases, the launcher consists of the tube in which the rocket is shipped. Other launchers may be of semipermanent construction, designed for firing a limited number of rounds or permanent, designed for firing a substantial number of rounds. Single tube launchers can be fired from the shoulder in standing, kneeling and sitting position. A bipod and rear monopod are normally used for firing in a prone position. Multiple tube launchers consist of a number of tubes in a cluster mounted on a carriage or vehicle. Rockets are muzzle loaded in the cluster and are fired singly in preset sequence.

c. Post Launchers. This type (ARL Mk 5-Navy) consists of front and rear pairs of posts attached to base plates, which are, in turn, attached to the underside of airplane wings. The number of pairs used is suited to the type of plane. This type of launcher is designated the "zero-length" because the rocket is free of the launcher after $1\frac{1}{2}$ to 3 inches of travel from its initial position. The rocket (Navy fixed-fin type) can be attached to the front post with a button-type stud and to the rear post by means of a loop-type lug. The fuze-arming control is built into the front post, and a latch and pigtail (the electric cable and plug) receptacle is built into the rear post.

d. T-Slot Launcher. This type of launcher (ARL Mk 4-Navy) consists of an assembly of single rails, each of which has a T-slot running its entire length for engaging button-type suspension lugs. A spring catch at the rear serves as a backstop and allows the entry and removal of the suspension lugs. An electrical receptacle for the rocket igniter plug and a hook for attaching the igniter cable are mounted at the rear of each rail. A snap for the attachment of the arming wire is mounted on the side of each rail near the midpoint.

e. Retractable Jettisoning Launcher. This type consists of front and rear post mechanisms installed in an airplane. The mechanism consists of a retracting post which may be caused to protrude from the lower surface of the wing. In the bottom of the forward post is a $\frac{3}{8}$ -inch hole into which a rearward pointing lug attached to the lug band of the 5.0-inch HVAR rocket, as modified (par. 74) for these launchers by rocket kit M34, may be inserted and held by a shear wire. The rear mechanism consists of right and left rear posts, carrying lead wires from the source of electricity in the airplane. These posts, when in the operating position, protrude from

the lower surface of the wings and, when a rocket is mounted on the launcher, extend into electrical sockets provided on the trailing edges of the rocket fins. A second rocket (lower rocket) may be hung under the first rocket (upper rocket); the lug (finger) on the forward lug band of the lower rocket is hooked into a hole on the bottom of the forward lug band of the upper rocket, and two fins of the lower rocket engage slots in the leading edges of fins of the upper rocket. Near the leading edge of the airplane wing, there is a bomb-arming control from which fuze arming wires extend to the noze fuzes of the rockets. Provision is made in the forward post for jettisoning the rockets.

f. Expendable Launchers. There is one general type of expendable launcher which consists of a shipping tube with tripod mount and represented by the M12 series for 4.5-inch rockets. Long wires are connected with the igniter leads to provide for firing from a safe distance. The M12 type launcher consists of a plastic or metal alloy tube in which the rocket and fuze are shipped, and a light adjustable tripod for mounting. Sights and mounting clamps are assembled to the launcher as shipped, and accessories, such as spades, batteries, and reels of wire, are packed in the spacers within. In using this type of launcher, the covers are removed and the rocket is fuzed. The tripod then is set up and adjusted and the launcher attached and aimed. The lead wires are unreeled to reach a safe firing position and the rockets are fired alone or in salvo by means of the batteries or magneto-type firing device.

12. Inspection of Rockets Prior to Use

When rockets are unpacked in preparation for use, the following conditions should prevail:

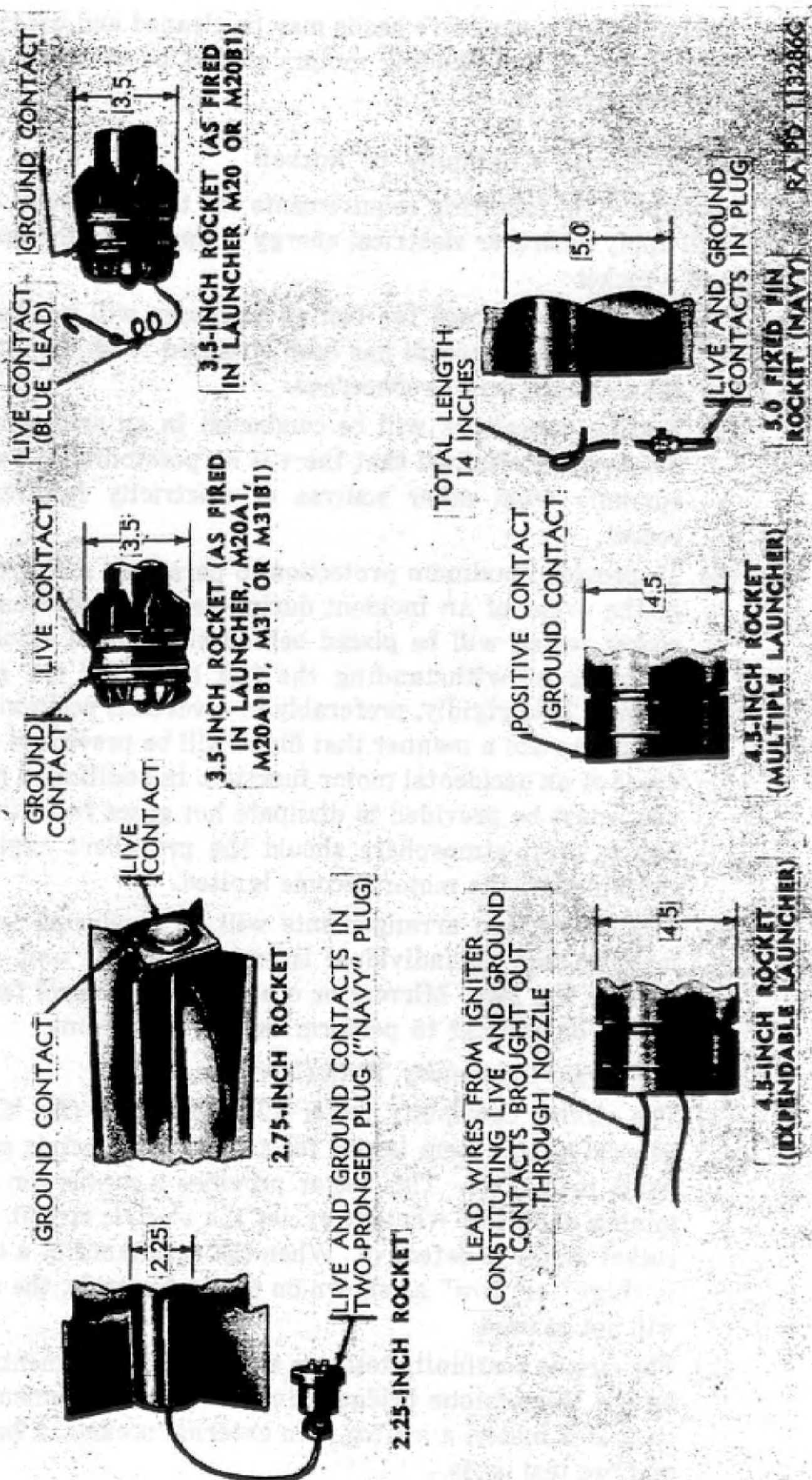
a. All safety devices, such as safety wires, safety pins, short-circuit devices (shorting strips or clips, and the like) should be in place.

b. Motors should be free of serious dents or deformations and fins should be straight.

c. Motor sealing disks and caps should be securely in place. Loose disks should be replaced and the rocket used if it can be ascertained that no moisture or other foreign material has entered the motor.

d. All components should be free of corrosion, dirt, grease, or other foreign material. This applies particularly to electrical contacts (fig. 5), threads, and fuze seats.

e. Temperature range, marked on the rocket, should not be exceeded at the time of use.



RA PD 113286C

Figure 5. Electrical contacts of rockets.

f. Excluding high-explosive heads may be cleaned and used; leaking chemical heads and exuding motors should be carefully segregated and destroyed.

13. Testing Circuit Continuity of Rockets

a. *General.* The following requirements for testing circuit continuity will apply wherever electrical energy is applied to the ignition system of a rocket:

- (1) The device selected for testing purposes will not be used unless prior approval has been obtained from the chief of the technical service concerned.
- (2) Testing operations will be conducted in an area where it has been determined that there is no possibility of induced currents from other sources of electricity igniting the rocket.

~~(3) To provide maximum protection to personnel and property~~

rust of the rocket
vertical position, nose
prevented in the
dition, a proper
from the test
explosives

rocket tested will be placed "down" so
(capable of withstanding the full thrust
motor) held rigidly, preferably in a vertical
down, in such a manner that flight will be prevented
event of an accidental motor function. In addition,
vent must be provided to dissipate hot gases
to open atmosphere without the prevention

contained in the motor become ignited.

- (4) Test connection arrangements will be conducted in such manner that no individual is exposed to the unit at the time of the test. Mirrors or other remote control features should be utilized to perform testing operations.

b. *Tester, Circuit Continuity, With Carrying Case.*

- (1) The circuit continuity tester 17-T-5505-57 (fig. 6) is a general supply item issued for testing the electric components in rockets. This tester provides a means for determining definitely whether or not the electric circuit in the rocket motor is defective. When the resistance of a circuit is "high" or "low" as shown on the tester scale, the rocket will not be used.
- (2) The circuit continuity tester is an electric instrument based on the Wheatstone bridge principle. The instrument consists of a meter, a switch, two external sockets, a battery, and two test leads.
- (3) The scale of the instrument (fig. 6) indicates the resistance in ohms of the electric circuit in the rocket motor. A

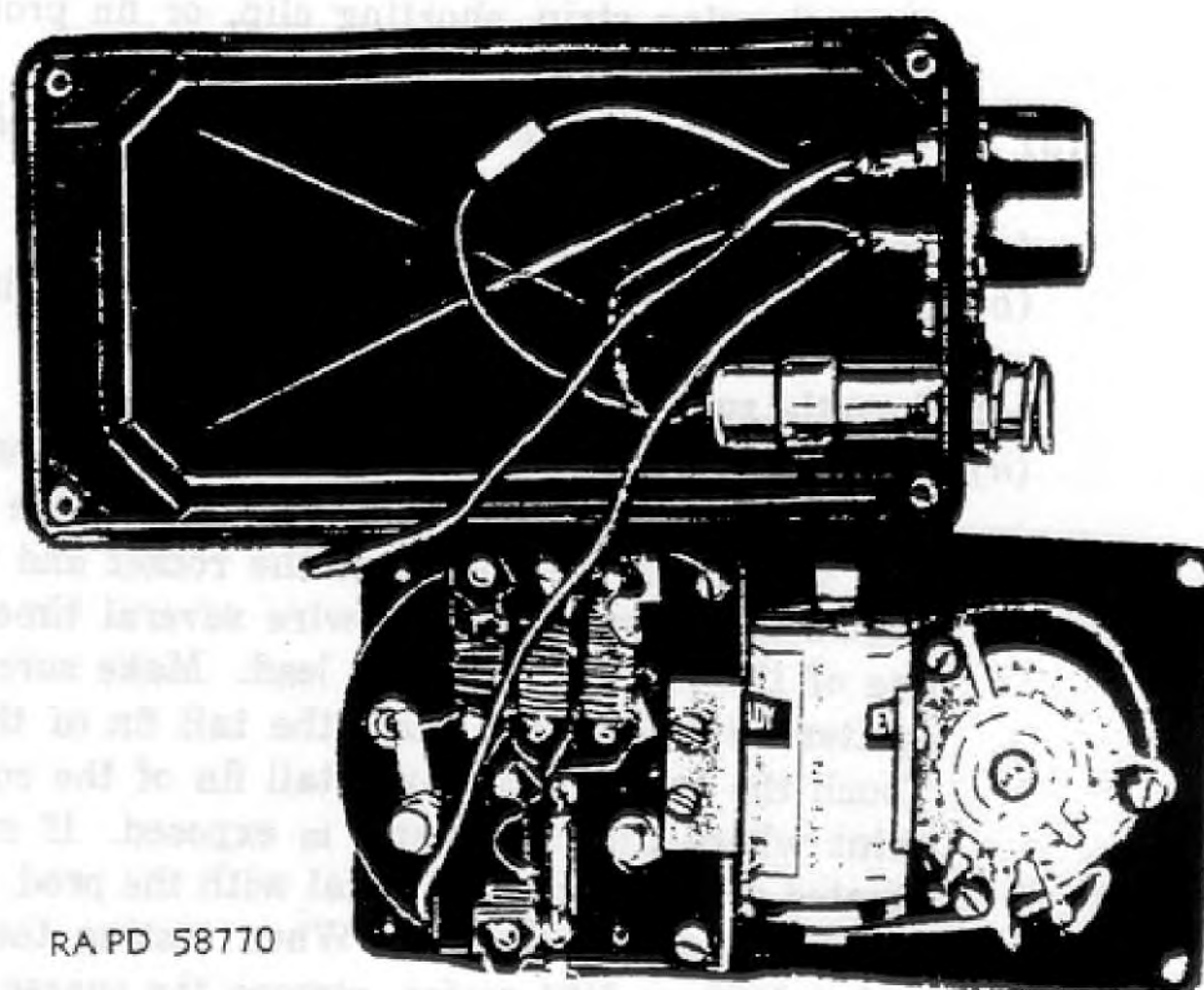


Figure 8. Circuit continuity tester—interior.

- (e) Remove the rocket plug from the socket and return shorting device to the plug. Turn the switch to the OFF position.
- (2) *Rockets with contact rings, shrouds, or contact disks.*
 - (a) Test the battery in accordance with c above.
 - (b) Connect the arming type plug of the test leads firmly into the Army socket on the instrument.
 - (c) Turn the switch to ROCK CONT.
 - (d) Remove shorting strip, shorting clip, or fin protector from rocket. Touch one prod of the test lead to one shroud, one contact ring, or one contact disk of the rocket. At the same time touch the other prod to the other shroud, contact ring, contact disk, or body of the rocket and note the movement of the pointer.
 - (e) If the pointer comes to rest within the space marked OK, the rocket is satisfactory for use. Do not use the rocket if the pointer comes to rest within the LOW or HIGH sections of the scale.
 - (f) Remove the prods from the rocket and remove the test leads from the instrument. Turn the switch to OFF. Re-

place shorting strip, shorting clip, or fin protector on rocket.

(3) *3.5-inch rockets (all models) and 4.5-inch rockets M20 and M21.*

- (a) Test the battery in accordance with *c* above.
- (b) Connect the Army type plug of the test leads firmly into the Army socket on the instrument.
- (c) Turn the switch to ROCK CONT.
- (d) Remove the shorting device from the rocket. When testing the 3.5-inch rocket, withdraw the blue auxiliary lead wire from the tail fin of the rocket and wrap the uninsulated portion of this wire several times around one of the prods of the test lead. Make sure that the igniter wire does not touch the tail fin of the rocket. Touch the other prod to the tail fin of the rocket at a point where the bare metal is exposed. If completely painted over, scratch the metal with the prod. Note the movement of the pointer. When testing the 4.5-inch rocket M20 or M21 series, remove the spacer from the launcher and wrap each of the two uninsulated wire ends from the spacer around the prods, one to each prod and proceed as before.

Note. When testing the continuity of 3.5-inch rockets M28A2, M29A2, M30, and T127E2 also check as indicated in (2) above.

- (e) If the pointer comes to rest within the space marked OK, the rocket is satisfactory for use. Do not use the rocket if the pointer comes to rest within the LOW or HIGH sections of the scale.
- (f) Disconnect the prods from the rocket and return the shorting clip to the rocket. Remove the leads from the instrument. Turn the switch to OFF.

e. Cautions.

- (1) Keep switch in OFF position at all times when the instrument is not in use. Failure to do so will cause the battery to run down.
- (2) Handle the instrument carefully at all times to prevent damage to the internal and external parts.
- (3) Prevent the instrument and carrying case from getting wet.
- (4) When placing the instrument in the carrying case, make sure the meter end is towards the bottom.

14. General Precautions

- a.* Rockets, in common with other types of ammunition, are de-

signed to be as safe in handling as is consistent with their function, and are packed to withstand all conditions ordinarily encountered in storage and transit. In order to insure that the ammunition will be in serviceable condition when required for use and to provide the highest possible protection to personnel and materiel, the precautions outlined in this paragraph and in paragraphs 15 and 16, which apply to all rockets, and the precautions specified in the description of each item will be observed.

b. Boxes of ammunition should not be handled roughly, dropped, slid, tumbled, "walked" on the corners, or struck, as in lining up a stack. Particular care should be taken in very cold weather to avoid dropping or rough handling of the rockets. Since at temperatures below -40° F., rocket propellant subjected to severe impact may break or crack making the motor likely to detonate when fired.

c. Rockets should be protected from sources of high temperatures such as steam lines and direct sunlight. Rockets will not be stored where the temperature may exceed 160° F., for periods as long as 4 hours per day. Rockets which are known to have been exposed to a temperature higher than that indicated as their upper limit (firing temperature limits are marked on the item) for more than 2 hours will not be fired until they have been cooled down. They will be placed in cool storage until they have returned to a safe temperature, and then they may be fired. Rockets should not be exposed to extreme, rapid, and recurrent variations in temperature beyond the temperature limits prescribed for them. Rockets that show signs of serious deterioration, as a result of exposure to extremes of temperature, will not be fired.

d. Since explosives are adversely affected by moisture, do not break the moisture resistant seal on the container until ready to use the rocket. Rockets removed from airtight containers, particularly in warm, damp climates, are subject to accelerated corrosion and deterioration, thereby causing them to become unserviceable.

e. Rocket components which are issued separately, should not be assembled in advance of anticipated requirements. Those assembled for use but not used will be returned to their original condition and packings.

f. Safety devices will be removed, as specified, in preparation for firing, but at no other time.

g. Packings will not be opened until the items are required for use or for inspection. Partly used containers and repacked items will be resealed and marked. They will be used first for subsequent requirements, in order that stocks of opened packages may be kept to a minimum.

h. Damaged packings will be repaired or replaced, and special care will be given in transferring all markings to new parts of the container.

i. Packings will not be opened, repaired, or replaced within 100 feet of a magazine or other store of explosives.

j. No rocket or component will be disassembled except as specifically authorized by the chief of the technical service concerned.

15. Precautions in Storage, Handling, and Use

a. Storage.

- (1) The composition of rocket propellants is such that they are somewhat more susceptible to deterioration than other types of propellants, if stored under adverse storage conditions. They should be stored in a dry, cool place, if possible, never in the direct rays of the sun. Rockets must be stored and transported within such temperature limits that the propellant will not be permanently impaired. Except as otherwise indicated, these limits are—

Lower limit —80° F. for period of not more than 3 days.

Upper limit 160° F. for periods of not more than 4 hours per day.

They should not be stored where temperatures are beyond the limits marked on the rocket. The prolonged exposure of rocket motors to either high or low temperatures will increase the normal rate of deterioration, or render the propellant more susceptible to malfunction, if subsequently handled improperly.

- (2) Separate rocket heads will be stored in accordance with regulations in TM 9-1903 for items of comparable loading, that is, HE-loaded heads as class 10, WP-loaded heads as class 2, and FS-loaded heads as class 11.
- (3) Rocket motors that are closed at the forward end with a closure having substantially the same strength as the motor body will be treated as rockets. Double-base rocket propellants are sensitive and on strong initiation may detonate rather than burn; as a consequence, separate rocket motors will be stored the same as fixed rounds (class 4), with the propellant computed as high-explosive.
- (4) Separately issued rocket fuzes are stored as class 6 fuzes.
- (5) Assembled rockets (complete round) are similar to rounds of fixed artillery ammunition with two important exceptions. The first, as noted above, is that the propellant will

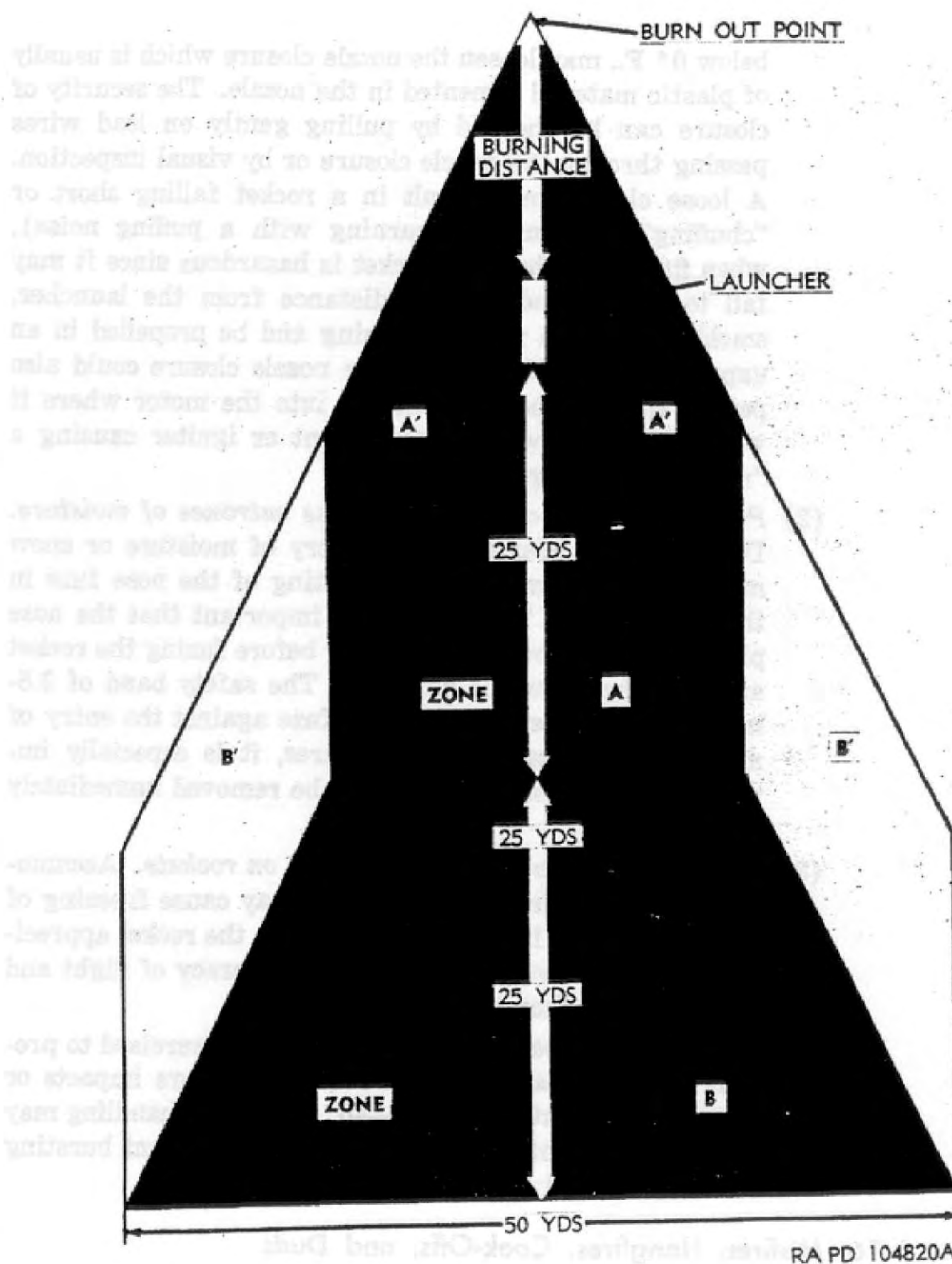


Figure 9. Back-blast danger area.

ture and possible subsequent formation of ice or frost within the motor.

- (1) Check for loose nozzle closures to prevent a "short range" or "chuffing" rocket. Wide and frequent temperature fluctuations, especially repeated fluctuations at temperatures

below 0° F., may loosen the nozzle closure which is usually of plastic material cemented in the nozzle. The security of closure can be checked by pulling gently on lead wires passing through the nozzle closure or by visual inspection. A loose closure may result in a rocket falling short or "chuffing" (intermittent burning with a puffing noise), when fired. A "chuffing" rocket is hazardous since it may fall to the ground a short distance from the launcher, smolder and then resume burning and be propelled in an unpredictable direction. A loose nozzle closure could also permit the entrance of moisture into the motor where it would freeze or wet the propellant or igniter causing a "misfire" or "hangfire."

- (2) *Protect the fuze cavity against the entrance of moisture.* During fuze operations, the entry of moisture or snow may prevent insertion or full seating of the nose fuze in the rocket head. Therefore, it is important that the nose plug only be removed immediately before fuzeing the rocket and that the rocket be kept dry. The safety band of 3.5-inch ground rocket seals the BD fuze against the entry of moisture. In freezing temperatures, it is especially important that the safety band only be removed immediately before firing.
- (3) *Prevent accumulation of ice or frost on rockets.* Accumulation of ice or frost on the rocket may cause freezing of the rocket to the launcher. If the ice on the rocket appreciably affects its weight and balance, accuracy of flight and range will be affected adversely.
- (4) *Handle rockets carefully.* Care should be exercised to prevent subjecting an unpacked rocket to severe impacts or drops at temperature below -40° F. Rough handling may cause breakage of the propellant and subsequent bursting of the motor body when the rocket is fired.

16. Misfires, Hangfires, Cook-Offs, and Duds

a. Misfire. A misfire is a complete failure to fire, which may be due to a faulty firing mechanism or a faulty element in the propelling charge explosive train. A misfire in itself is not dangerous, but since it cannot be immediately distinguished from a delay in the functioning of the firing mechanism or from a hangfire (*b* below), it should be considered as a possible delay firing, until such possibility has been eliminated. Such delay in the functioning of the firing switch, for example, could result from the presence of foreign matter such as grit, sand, frost, ice, or improper or excessive oil or grease. These

conditions might create, initially, a partial mechanical or electrical restraint which, after some indeterminate delay, is overcome as a result of additional attempts to fire. In this connection, no round should be left in a hot weapon any longer than circumstances require, due to the possibility of a cook-off (c below).

b. Hangfire. A hangfire is a delay in the functioning of a propelling charge explosive train at the time of firing. The amount of the delay is unpredictable but in most cases will fall within the range of a split second to several minutes. Therefore, a hangfire cannot be distinguished immediately from a misfire.

Caution: Do not assume that an initial failure of a round to fire is a misfire; it may be a hangfire. Allow an interval of time to elapse before approaching the launcher. During the time interval, the launcher will be kept trained on the target and personnel will stand clear of the muzzle and path of the back-blast (fig. 9). The time intervals described in (d (2) below), must be observed after a failure to fire. Those time intervals, based on experience and considerations of safety, have been established to minimize the danger associated with a hangfire, and to prevent the occurrence of a cook-off.

c. Cook-Off. A cook-off is the functioning of any or all of the explosive components of a round chambered in a very hot launcher due to the heat of the launcher. The igniter and propelling charge, respectively, are more likely to cook-off than the head or the fuze. If the igniter or propelling charge should cook-off, the round may be propelled (fired) from the launcher with normal velocity, even though no attempt was made to fire the igniter by actuating the firing switch. Although there may be uncertainty as to when or whether the round will fire, the precautions to be observed are the same as those prescribed for a hangfire.

Warning: If a bursting charge explosive train should cook-off, injury to personnel and destruction of the rocket launcher may result. To prevent a cook-off, a round of ammunition, which has been loaded into a very hot launcher, should be fired or removed within the time prescribed in (d(2) below) to prevent heating to the point where a cook-off may occur.

Caution: In the case of an explosive round, chambered in a very hot launcher, which can neither be fired nor removed as prescribed in a above, all personnel will stand clear of the launcher until such time as the launcher and chambered round are cool, to avoid the danger from a possible cook-off of the explosive projectile.

d. Unloading an Unfired Round.

(1) *General.* After a failure to fire, due to the possibility of a

hangfire or a cook-off, the following general precautions, as applicable, will be observed until the round has been removed from the launcher and the cause of failure determined.

- (a) Keep the launcher trained on the target, and all personnel clear of the muzzle and path of back-blast (fig. 9).
- (b) Make additional attempts to fire as prescribed in (2) below.

- (2) *Before removal of the round.* Definite intervals, for waiting after failure to fire and after additional attempts to fire, have been established on the basis of experience and characteristics of the launcher as follows:

Warning: After a failure to fire, actuate the firing switch two additional times in attempts to fire. If the rocket launcher still fails to fire, wait 15 seconds from the last attempt to fire, then check the electrical circuit for breaks, shorts, and poor contacts before another attempt to fire. After making any necessary adjustments, again actuate the firing switch three times. If the launcher still fails to fire, wait 15 seconds from the last attempt to fire before again checking the electrical circuits. After making any other necessary adjustments again actuate the firing switch three times in attempts to fire. If the launcher still fails to fire, wait 15 seconds before removing the round, which is to be considered at fault unless subsequent examination reveals a defect in electrical circuits not previously detected.

- (3) *After removal of the round.* The round, after removal from the launcher will be kept separate from other rounds until it has been determined whether the round or the firing mechanism was at fault. If the round has been determined to be at fault, continue to keep it separate from other rounds until disposed of. However, if examination reveals that the firing mechanism was at fault, the round may be released and fired after correction of the faulty firing mechanism.

e. Duds. A dud rocket is one which has been launched but has failed to function. It must be regarded as likely to function at any time. Unless the cause of the malfunction is evident without moving the dud (for example, failure to remove safety pin or fuze dropping off in flight), it will not be moved but will be destroyed in place by authorized personnel in accordance with the provisions of TM 9-1903.

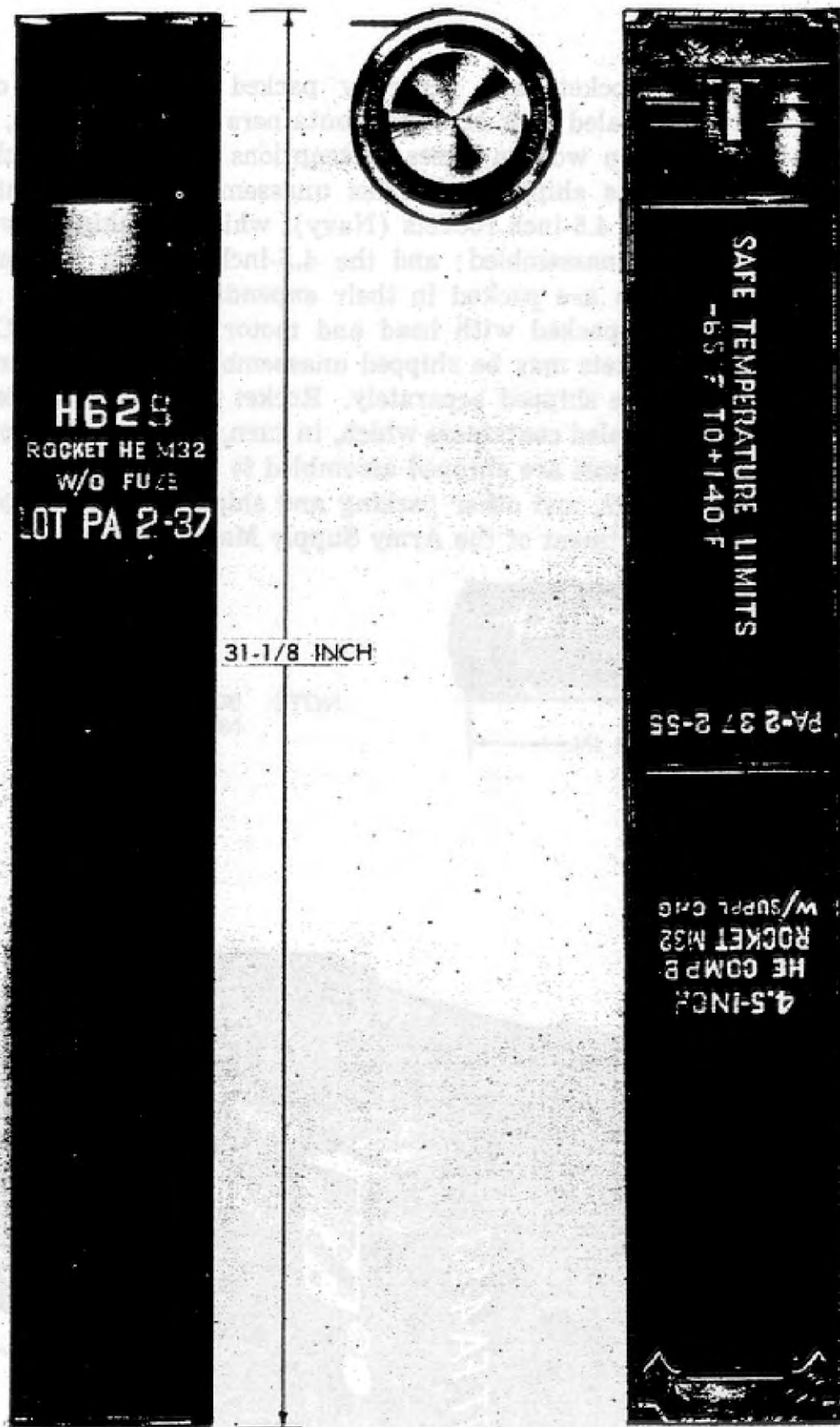
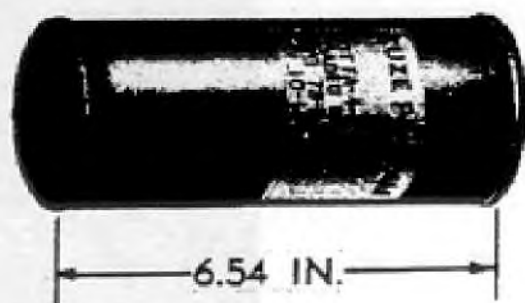


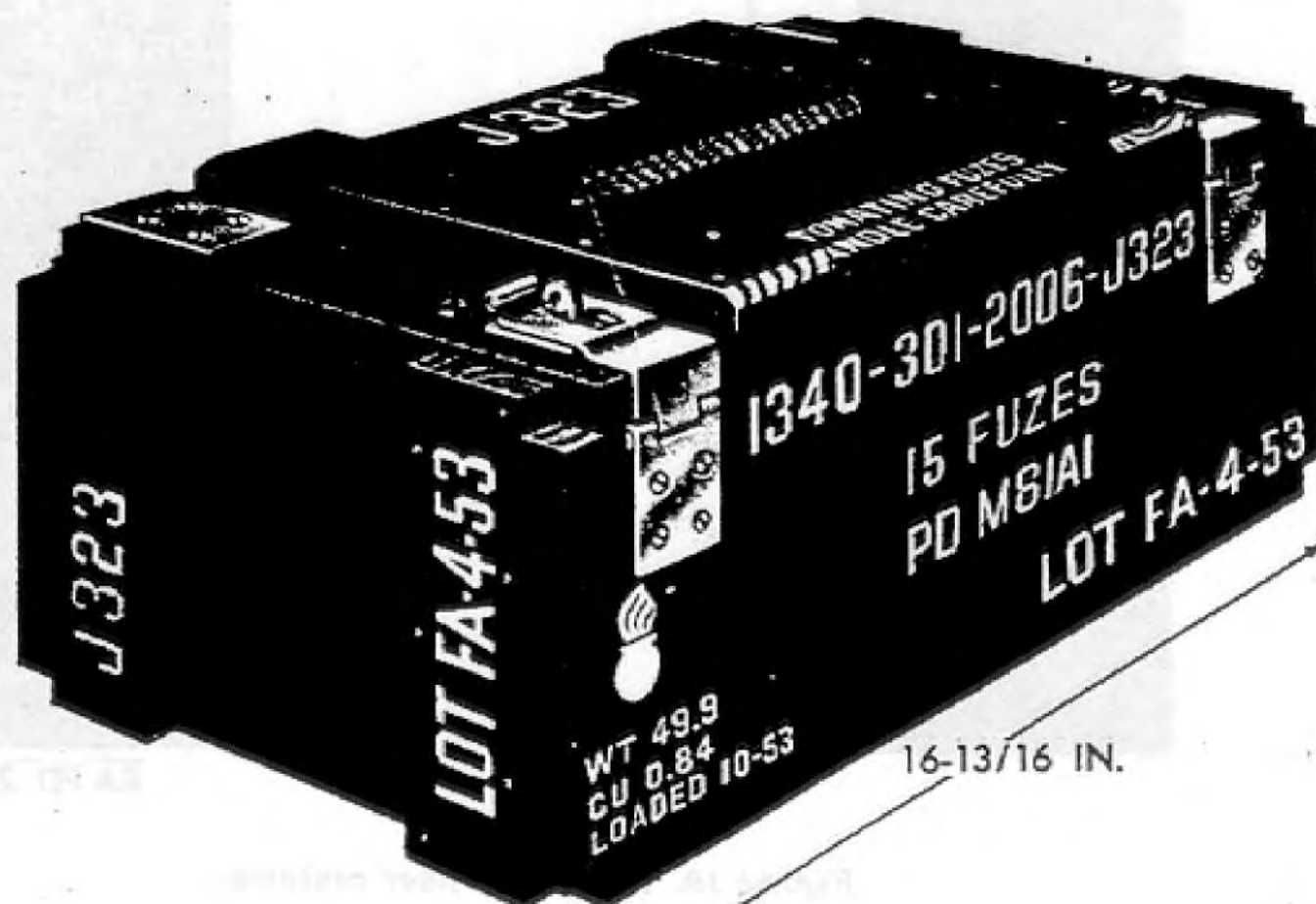
Figure 10. Packing in fiber container.

17. Packing

Ground rockets are generally packed as assembled complete rockets in sealed fiber or metal containers (fig. 10) which, in turn, are packed in wooden boxes. Exceptions are the 3.25-inch rocket M2, which is shipped with fins unassembled but present in the packing; the 4.5-inch rockets (Navy), which are shipped with head and motor unassembled; and the 4.5-inch rockets M20 and M21 series, which are packed in their expendable launchers. Aircraft rockets are packed with head and motor unassembled. Complete aircraft rockets may be shipped unassembled in one box or components may be shipped separately. Rocket nose fuzes are packed in individual sealed containers which, in turn, are packed in boxes (fig. 11). Base fuzes are shipped assembled to the rocket head. Dimensions, weights, and other packing and shipping data are published in the Department of the Army Supply Manual 9-5-1340.



NOTE: BOX STRAPPING
NOT SHOWN



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Figure 11. Fuze packing.

CHAPTER 2

GROUND ROCKETS

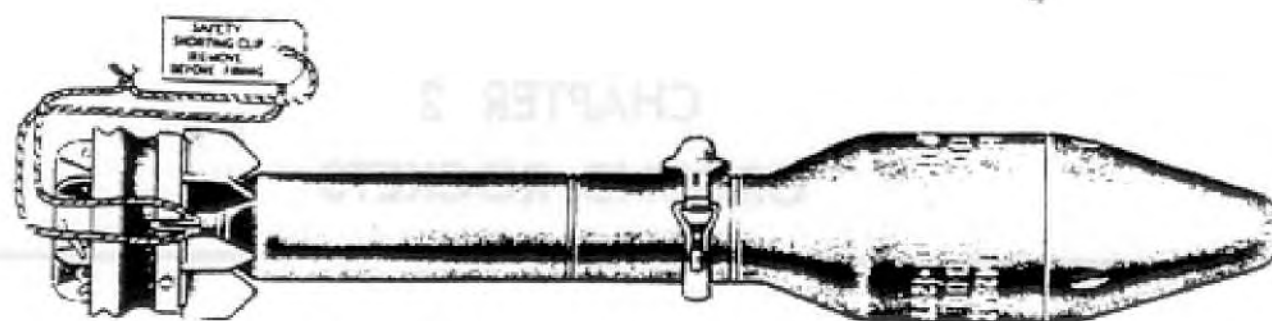
Section I. 3.5-INCH ROCKETS

18. General

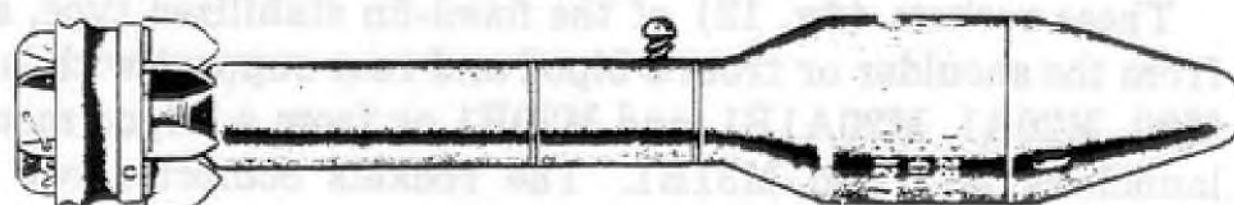
These rockets (fig. 12) of the fixed-fin stabilized type, are fired from the shoulder or from a bipod and rear support with launchers M20, M20A1, M20A1B1, and M20B1 or from a tripod mount with launchers M31 and M31B1. The rockets comprise two types—rockets M35, M35A1, and M36 with velocity approximately 485 feet per second and rockets M28, M28A2, M29A1, M29A2, T127E2, and M30 with velocity approximately 320 feet per second. The 3.5-inch rockets M35, M35A1, and M36 burn completely within the launcher at all operating temperatures. At normal operating temperatures, the 3.5-inch rockets M28, M28A2, M29A1, M29A2, T127E2, and M30 burn almost completely in the launcher. At freezing temperatures the rockets M28, M28A2, M29A1, M29A2, T127E2, and M30 may continue to burn ("after burning") after the rocket has been fired from the launcher. Rockets with high-explosive head are used against armored targets. Smoke rockets are used for smoke screening. Rockets with inert head and sub-caliber rockets are used for practice. Dependent on the type of head, these rockets are designated high-explosive, antitank (HE, AT), practice or smoke (WP). Practice rockets of smaller caliber are designated subcaliber. A rocket M35, M35A1, or M36 consists of a head assembly and motor assembly. A rocket M28, M28A2, M29A1, M29A2, T127E2, or M30 consists of a head assembly and fuze and motor assembly.

a. Head Assembly.

- (1) *Rockets M35, M35A1, and M36.* In external contour, the head assemblies of these rockets are similar being cylindrical with tapered convex rear portion, tapered concave ogive, and flat nose. The HE, AT rockets M35 and M35A1 differ from the practice rocket M36 in having an unpainted aluminum nose and fuze system. The head is threaded internally at the rear end to receive the motor assembly.
- (2) *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30.* In external contour, the head assemblies of these rockets



A—ROCKET M28A2, AS PACKED



B—ROCKET M28A2, AS FIRED



C—ROCKET M35, AS PACKED



D—ROCKET M35, AS FIRED

RA PD 113352C

Figure 12. 3.5-inch rockets (as fired and packed).

are similar being cylindrical with tapered forward and rear positions. The head is threaded externally at the rear end to receive the fuze.

b. Fuze. Fuzes used with the 3.5-inch rockets are base detonating (BD) type M404, M404A1, and M404A2, the point initiating base detonating (PIBD) type M408 and M408E1, and the dummy M405.

- (1) *PIBD fuzes M408 (T2030E4) and M408E1.* The fuze is contained in the head of the HE, AT rocket and consists of a nose assembly and base assembly connected electrically by an insulated wire passing through a conduit

in the head. A safety band (fig. 12), which fits around the rear portion of the head and is in place during shipping and handling, prevents accidental functioning of the fuze. It is removed immediately before loading the rocket in the launcher. See paragraph 41 through 51 for fuze description.

- (2) *BD fuzes M404, M404A1, and M404A2 and dummy fuze M405.* The fuze, which serves also as a coupling for the head and motor assembly, is cylindrical. It is threaded externally at the forward end to fit into the head assembly and internally at the rear end to receive the motor assembly. A safety band (fig. 14), which fits around the fuze and is in place during shipping and handling, seals the fuze against the entry of moisture and prevents accidental functioning. It is removed immediately before loading the rocket in the launcher. See paragraphs 41 through 51 for fuze description.

c. Motor Assembly.

- (1) *Rockets M35, M35A1, and M36.* The motor assembly is threaded externally at the forward end to engage the head. It consists of the motor body, motor closure, tail assembly, propelling charge, shorting clip assembly, and igniter M22. The tail assembly is press fitted over the

positioned by the

contains the propelling charge which is

ing at the tail end

of the motor and by the cushioning ri

a safety device to prevent electrical ignition of

serves as

circuit. The motor body

the loaded motor by shorting the

is a steel tube threaded externally at the forward end to

engage the closure and disk assem

nozzle at the rear and tapered to the

(b) *Propelling charge.* The propelling charge consists of 19 monoperforated cylindrical extruded grains of solvent propellant M7. Each grain is 5.7 inches long and 0.33 inches in diameter. The grains are lengthwise in the motor suspended from screws at the head end. Refer to paragraph 93.

(c) *Igniter.* The igniter M38 is a short cylindrical plug hollowed out to contain a charge of black powder and an electric squib. The igniter, which serves as nozzle closure for the motor, is positioned in the nozzle. The lead wires from the squib pass through the nozzle into the extension cone of the tail assembly where one lead wire is connected to the ground lead terminal (red).

(2) *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30.* The motor assembly (fig. 14) is threaded externally at the forward end to engage the fuze. It consists of the motor body, tail assembly, shorting clip assembly, nozzle closure, propelling charge, igniter M20, trap and spacer assembly, and disk and closure assembly. The tail assembly is press fitted over the knurled rear portion of the motor body. The motor body contains the trap and spacer assembly, propelling charge, and igniter. The motor is sealed at the rear by a plastic nozzle closure and at the forward end by the disk and closure assembly. The motor body is a steel tube threaded internally at the forward end to receive the disk and closure assembly (fig. 14), constricted to a nozzle internally at the rear and tapered to the knurled surface externally at the rear. The trap and spacer assembly consists of the disk-like trap to which the spacer blades are staked and is positioned in the motor lengthwise so that the blades divide the motor chamber into four compartments.

(a) *Tail assembly.* The tail assembly is similar to that of the 3.5-inch rockets M35, M35A1, and M36.

(b) *Propelling charge.* The propelling charge consists of 12 monoperforated cylindrical extruded grains of solvent propellant M7. Each grain is 5 inches long and $\frac{3}{8}$ inch in diameter. The propellant grains are lengthwise, three in each of the four compartments formed by the spacer blades. Refer to paragraph 93.

(c) *Igniter.* The igniter M20, which consists of a short cylindrical plastic case containing a black powder charge and an electric squib, is positioned in the forward end of the motor fitting in the recessed portion of the motor closure. The lead wires from the electric squib pass from the igniter, running parallel to the propellant

grains, to the nozzle where one lead wire is connected to the ground lead cable (green) and the other to the live lead cable (red).

d. Electric Circuit.

(1) *Rockets M35, M35A1, and M36.* The electrical circuit, which comprises the igniter, the ground terminal, the live terminal, the support ring, the contact ring, and the shorting clip, provides for firing the rocket from the launcher and for short circuiting the rocket during shipping and handling. Live contact is made by direct contact between the launcher and the contact ring (launchers M20A1, M20A1B1, M31, and M31B1). The contact ring is connected to one igniter lead wire. The launcher makes ground contact with the groove of the support ring. The other igniter lead wire is connected to the support ring. The shorting clip spring is assembled over the edge of the contact ring and support ring providing a direct connection between the support ring (ground contact) and contact ring (live contact) and thus "short circuiting" the igniter. The rocket cannot be fired while the shorting clip is in place.

(2) *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30.* The electrical circuit for these rockets comprises the igniter, the terminal lead assembly (ground), the terminal lead assembly (live and auxiliary), the support ring, the contact ring, and the shorting clip. Live contact is made by withdrawing the blue auxiliary lead cable coiled in the nozzle extension and attaching it to the launcher contact spring (launchers M20 and M20B1). Both the contact ring and the blue auxiliary lead cable are connected to the red live lead cable which is connected to one igniter lead wire. The launcher makes ground contact with the groove of the support ring. The green lead cable is connected to the support ring and also to the other igniter lead wire. The shorting clip is assembled the same as for rockets M35 and M36 ((1) above).

e. Identification.

(1) *Rockets M35, M35A1, and M36.* The rocket may be identified by the concave nose with flat end and the removable safety band near the motor end of the head. Painting and marking for identification are in accordance with the basic scheme prescribed in TM 9-1900.

(2) *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30.*

The rocket may be identified by the removable safety band which is fitted around the base detonating fuze located between the head and motor. Painting and marking for identification are in accordance with the basic scheme in TM 9-1900.

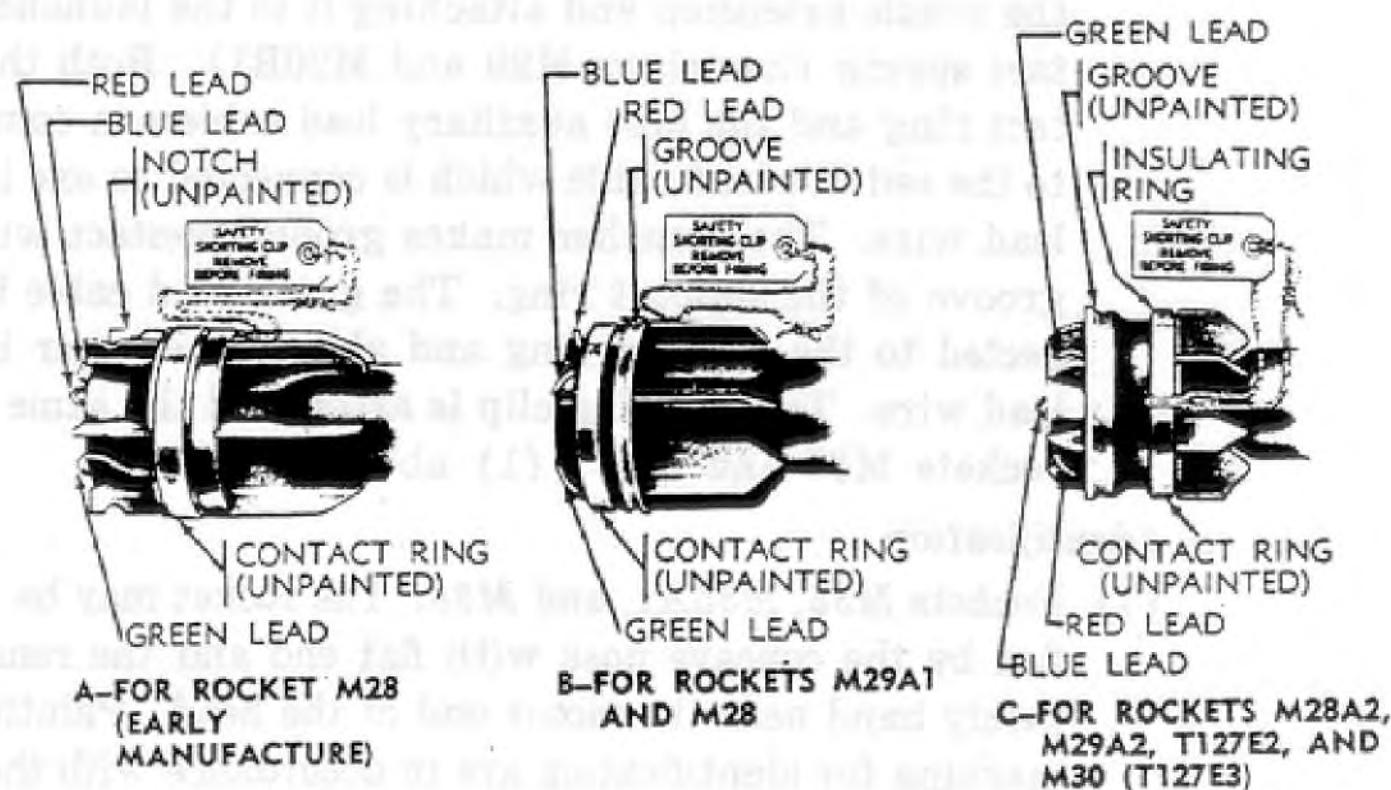
f. Packing and Shipping. The rockets are packed and shipped one per fiber or metal container, three containers per wooden box. Packing and shipping data appear in SM 9-5-1340.

g. Differences Between Modifications of 3.5-Inch Rocket M28-Series, M29-Series, T127E3, and M30. The modifications of HE, AT rocket M28 series and practice rocket M29 series differ principally in the trap and spacer assembly and in the tail assembly (fig. 13). The modifications of practice rocket M29 series differ from each other also in the construction of the head. The modifications of WP smoke rocket M30 and T127E2 differ in the internal construction of the head, both modifications using the same motor assembly.

h. Precautions in Firing. General firing precautions are given in paragraphs 29 through 37. In addition, the following are applicable to 3.5-inch rockets:

(1) *Rockets M35, M35A1, and M36.*

(a) At temperatures below freezing, it is important that the safety band not be removed until just before firing and that the rocket be kept dry. When the band is removed, moisture may enter the opening in the head and freeze, preventing reassembly of the band, if the rocket is not used.



RA PD 212996A

Figure 13. 3.5-inch rockets—tail modifications.

(b) When loading a rocket in launcher M20 or M20B1, make sure that the yoke of the contactor latch is properly engaged in the groove of the support ring. If the latch is engaged forward of the fins, the rocket may be prevented from being expelled from the launcher and injury to personnel and damage to materiel may result.

(2) *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30.*

(a) Since the rocket may burn for a short time beyond the launcher, placing the operating personnel in the "back-blast" areas (fig. 9), care should be taken to protect the eyes at all temperatures.

(b) At temperatures below freezing, face and hand protection are mandatory since burning of the propellant continues after the rocket has been projected from the launcher.

(c) At temperatures below freezing, it is important that the safety band (fig. 14) not be removed until just before firing and that the rocket be kept dry. When the band is removed preparatory to loading the rocket in the launcher, the ejection pin moves outward to the locked position leaving an opening around the pin permitting moisture to enter the fuze cavity and freeze. Ice or frost within the fuze may prevent functioning of the fuze.

(d) When loading a rocket in the launcher M20 or M20B1, make sure that the yoke of the contactor latch is properly engaged in the groove of the support ring. If the latch is engaged forward of the fins, the rocket may be prevented from being expelled from the launcher and injury to personnel and damage to materiel may result.

i. Preparation for Firing.

(1) *Rockets M35, M35A1, and M36.*

(a) Remove from packing and inspect for serviceability. Should it be considered necessary to test for continuity, test with the circuit continuity tester (par. 14).

(b) Before loading the rocket in the launcher, remove the shorting clip from the tail and safety band from the head.

(c) Restore rockets prepared for firing but not fired to their original condition and packing. Mark the packings of serviceable rockets for prior use in order that opened packages will be kept to a minimum.

(2) *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30.*

(a) Remove from packing and inspect for serviceability. Check for the presence of the base detonating fuze.

Should it be considered necessary to test for continuity, test with the circuit continuity tester (par. 14).

(b) Before loading the rocket into the launcher, remove the shorting clip from the tail and remove the safety band from the fuze.

(c) Test the ejection pin of the fuze to insure that it is free from binding. This is done in the case of the BD fuze M404A1, which can be identified by its *square* ejection pin, by merely depressing the pin with the fingers and releasing it. It is done in the case of the BD Fuze M404A2, which can be identified by its *round* ejection pin, by depressing the pin with the fingers, and then twisting it and releasing it. If the ejection pin binds while being depressed or twisted, reject the rocket and report the condition to the Ordnance Technical Service Personnel.

Caution: When loading the rocket into the launcher, depress the ejection pin with the fingers until the pin is in the bore of launcher. Failure to hold the ejection pin depressed while loading the rocket may result in the ejection pin coming in contact with the breech end of the launcher tube and thereby becoming bent. This procedure gives greater assurance of proper functioning of the rocket.

(d) If the rocket is prepared for firing and not fired, restore the rocket to its original condition and packing. Mark the packings of serviceable rockets for prior use in order that opened packages will be kept to a minimum.

j. Subcaliber Rocket. The 27-mm subcaliber rocket is fired from 3.5-inch rocket launchers M20, M20A1, M20A1B1, M20B1, M31, and M31B1 as practice ammunition in lieu of the 3.5-inch rocket for reasons of economy. The subcaliber rocket is fired utilizing the 3.5-inch rocket launcher firing mechanism with a subcaliber device inserted in the bore. The 27-mm subcaliber rockets matches 3.5-inch rockets M35, M35A1, and M36 ballistically.

19. Rocket, High-Explosive, 3.5-Inch: AT, M28

The rocket is authorized for firing in launchers M20 and M20B1 only. The rocket is similar to that described in paragraph 20 except for the fuze, tail assembly, and trap and spacer assembly. Base detonating fuze M404 is used with this rocket. The tail assembly has short fin blades and a 360° grooved support ring forward of the contact ring (fig. 13). Rockets of early manufacture may have

long fin blades notched at the rear, a cast trap, and square spacer blades. See table I for data.

20. Rocket, High-Explosive, 3.5-Inch: AT, M28A2

This rocket (fig. 14) is intended for use against armored targets. When fired from launcher M20 or M20B1 live contact is made by withdrawing the blue auxiliary lead wire coiled in the nozzle and attaching it to the contact spring of the launcher. When fired from launcher M20A1, M20A1B1, M31, or M31B1, the blue auxiliary lead wire is not used since the launcher makes live contact directly to the contact ring of the rocket. The rocket M28A2 consists of the HE, AT head M28A2, BD fuze M404A2 or M404A1, and the older motor assembly. The head contains a copper cone, whose apex is to the rear, which acts to shape the high-explosive charge of 1.90 pounds of composition B. The penetration effect is derived from the shaped charge. The tail assembly differs from earlier 3.5-inch rocket models in that the support ring is wider and has a 360° latching groove located to the rear of the contact ring (fig. 13). See table I for data.

21. Rocket, High-Explosive, 3.5-Inch: AT, M35 (T205E1)

This rocket (fig. 15) is intended for use against armored targets. Since the modern launchers do not require the blue lead wire, it has been eliminated from this round. When fired from launcher

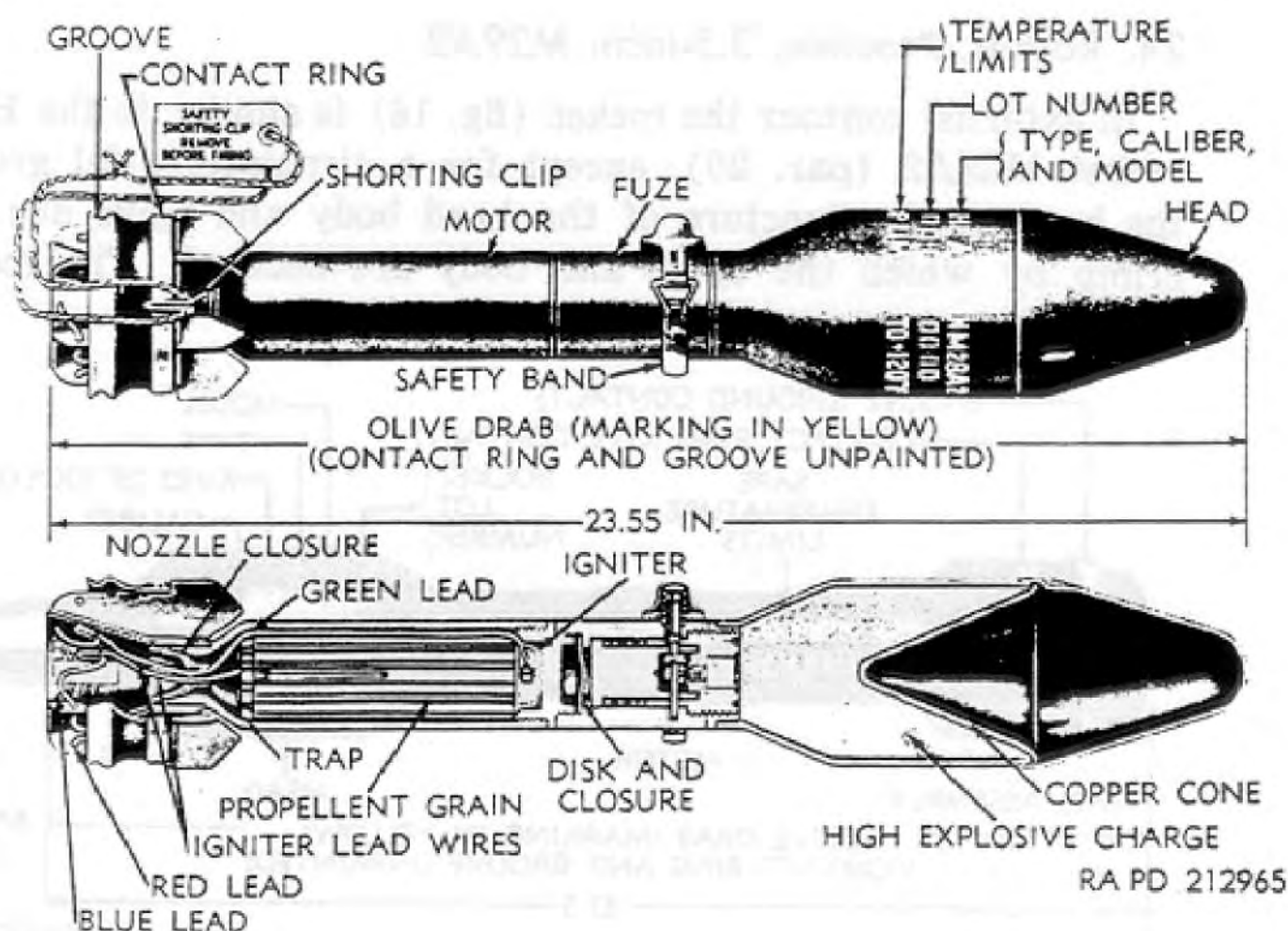


Figure 14. Rocket, high-explosive, 3.5-inch: AT, M28A2.

M20A1, M20A1B1, M31, or M31B1, the blue auxiliary lead wire is not necessary since the launcher firing mechanism makes live contact directly to the contact ring of the rocket. The rocket M35 consists of the HE, AT head M35 containing PIBD fuze M408 and the newer motor assembly (used with rockets M35 and M36). Contained in the head is a copper cone, apex to the rear, which acts to shape the high-explosive charge of 1.60 pounds of composition B. The penetration effect is derived from the shaped charge. See table I for data.

22. Rocket, High-Explosive, 3.5-Inch: AT, M35A1 (T205E3)

This rocket is the same as Rocket M35 (par. 21) except that the head contains a double angle cone. The Rocket M35A1 uses fuze M408E1. See table I for data.

23. Rocket, Practice, 3.5-Inch: M29A1

This rocket is authorized for use in launchers M20 and M20B1 only. The rocket is similar to the practice rocket described in paragraph 24. It differs in the head and trap and spacer assembly. The ogive is attached to the head body by four screws staked to the ogive. Some rockets may have the cast trap and square spacer blades. Rockets of manufacturing alternative are assembled with the HE, AT head metal parts inert loaded with plaster of paris. See table I for data.

24. Rocket, Practice, 3.5-Inch: M29A2

In external contour the rocket (fig. 16) is similar to the HE, AT rocket M28A2 (par. 20), except for a circumferential groove in the head at the juncture of the head body and ogive due to the crimp by which the ogive and body are secured. The rocket is

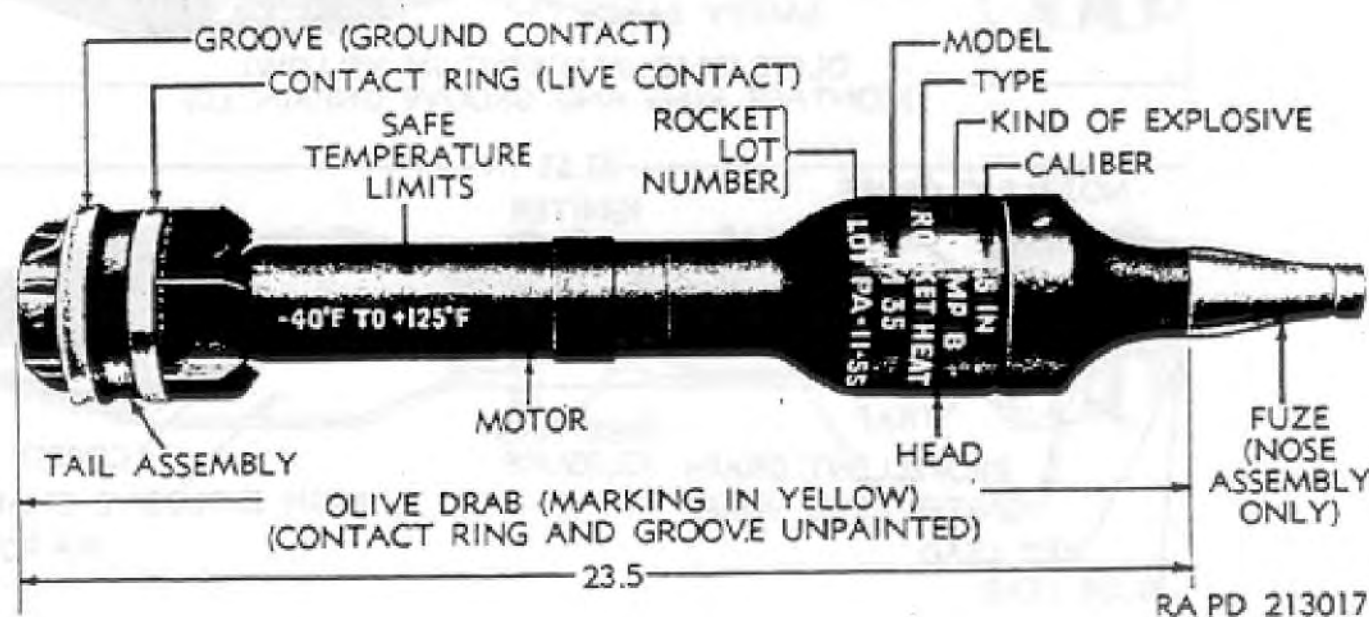


Figure 15. Rocket, high-explosive, 3.5-inch: AT, M35 (T205E1) (as fired).

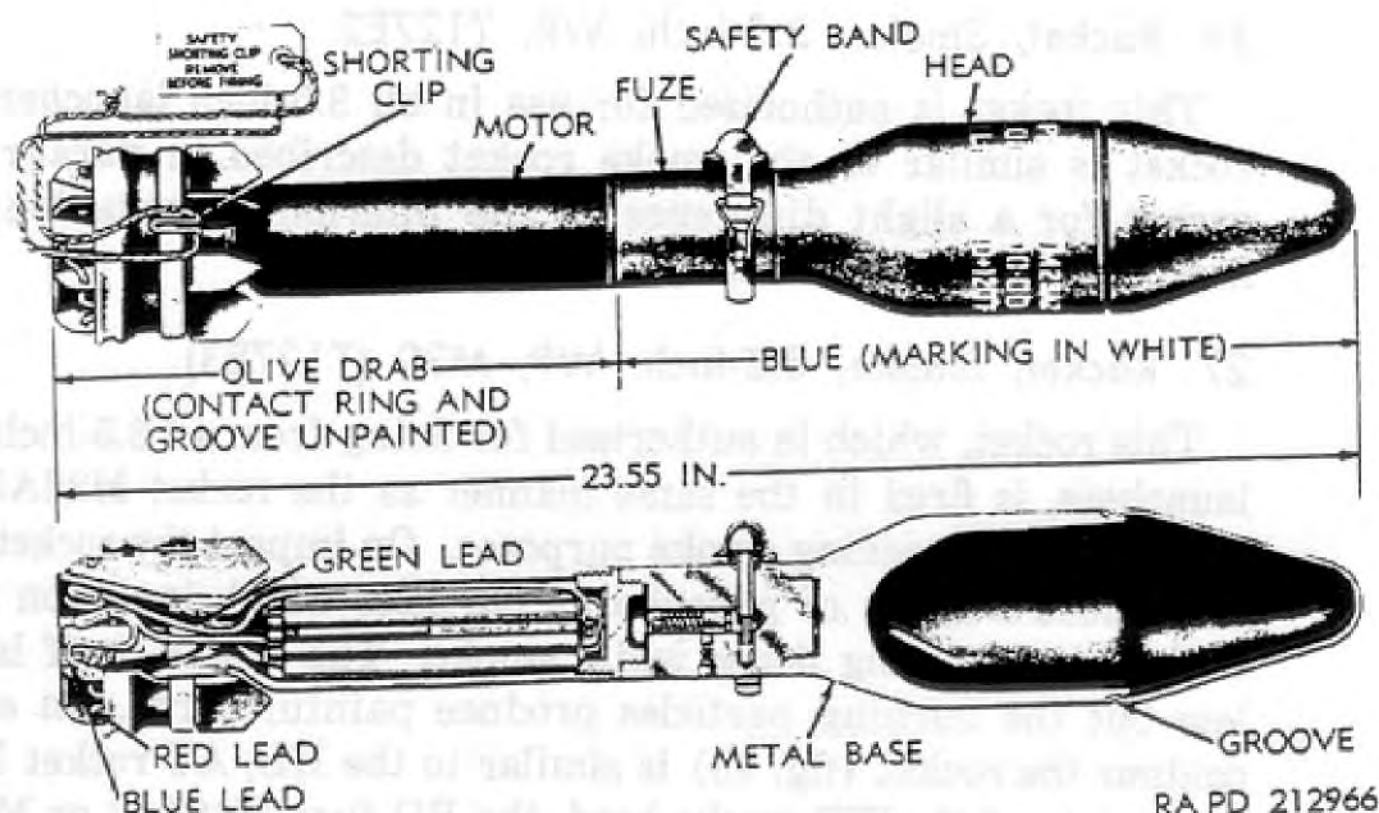


Figure 16. Rocket, practice, 3.5-inch: M29A2.

authorized for firing in all 3.5-inch rocket launchers in a manner similar to the HE, AT rocket. The rocket consists of a hollow head, dummy fuze M405, and the improved motor assembly. Rocket M29A2 of an early manufacturing alternative is identical in contour with the rocket M28A2, except for the lack of crimping groove in the head, consisting of the head metal parts of the rocket M28A2 inert loaded with plaster of paris. See table I for data.

25. Rocket, Practice, 3.5-Inch: M36 (T206E1)

In external contour the rocket (fig. 17) is similar to the HE, AT rocket M35 (par. 21). The rocket is authorized for firing in all 3.5-inch rocket launchers in a manner similar to the HE, AT rocket. The rocket consists of a hollow cast iron head, which matches the weight of the head M35, and the new motor assembly. Ballistically, this rocket matches HE, AT rocket M35. See table I for data.

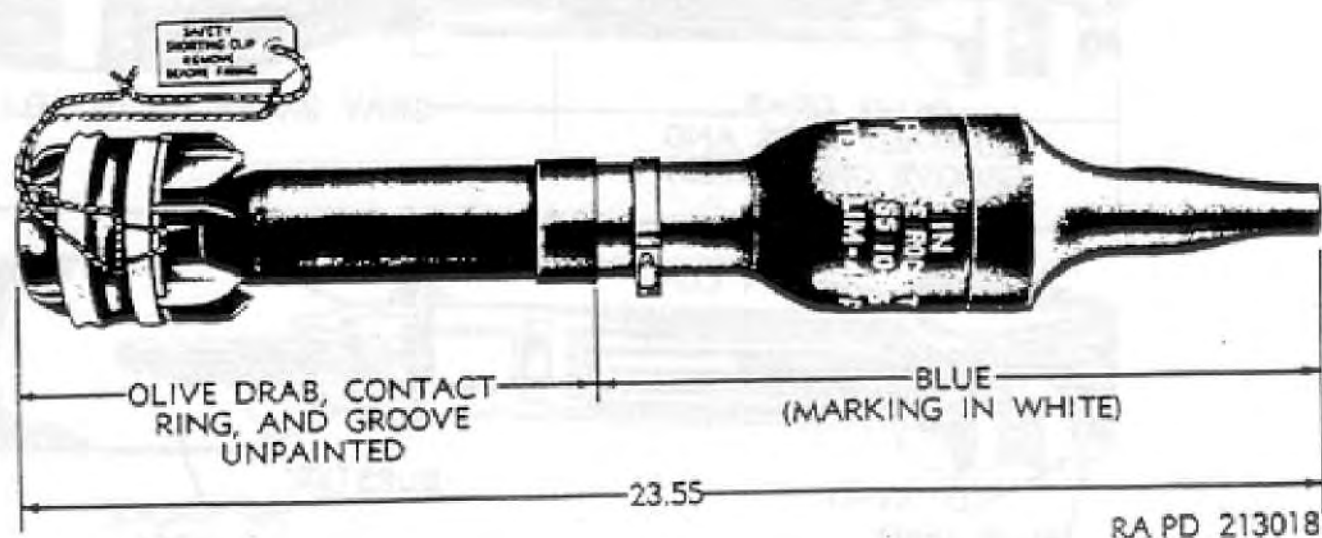


Figure 17. Rocket, practice, 3.5-inch: M36 (T206E1).

26. Rocket, Smoke, 3.5-Inch: WP, T127E2

This rocket is authorized for use in all 3.5-inch launchers. The rocket is similar to the smoke rocket described in paragraph 27 except for a slight difference in the internal construction of the head. See table I for data.

27. Rocket, Smoke, 3.5-Inch: WP, M30 (T127E3)

This rocket, which is authorized for firing from all 3.5-inch rocket launchers, is fired in the same manner as the rocket M28A2. It is intended for screening smoke purposes. On impact the rocket bursts to produce a spray of phosphorus particles which ignite on contact with air generating dense white smoke. The smoke itself is harmless but the burning particles produce painful burns. In external contour the rocket (fig. 18) is similar to the HE, AT rocket M28A2. It consists of the WP smoke head, the BD fuze M404A1 or M404A2, and the service motor assembly. The head is internally threaded at the rear end and contains a 2.33-pound charge of white phosphorus. At the rear it has a union internally threaded to receive the fuze, the burster casing M8 is press fitted into the union, and the steel body is fitted over it. The steel ogive and the internal steel dome, which closes the forward end of the filler cavity, are attached to the body. See table I for data.

28. Rocket, Subcaliber, 27 Millimeter: Practice, T265

This rocket (fig. 19) is authorized as practice ammunition for 3.5-inch rocket launchers adopted for this application by the in-

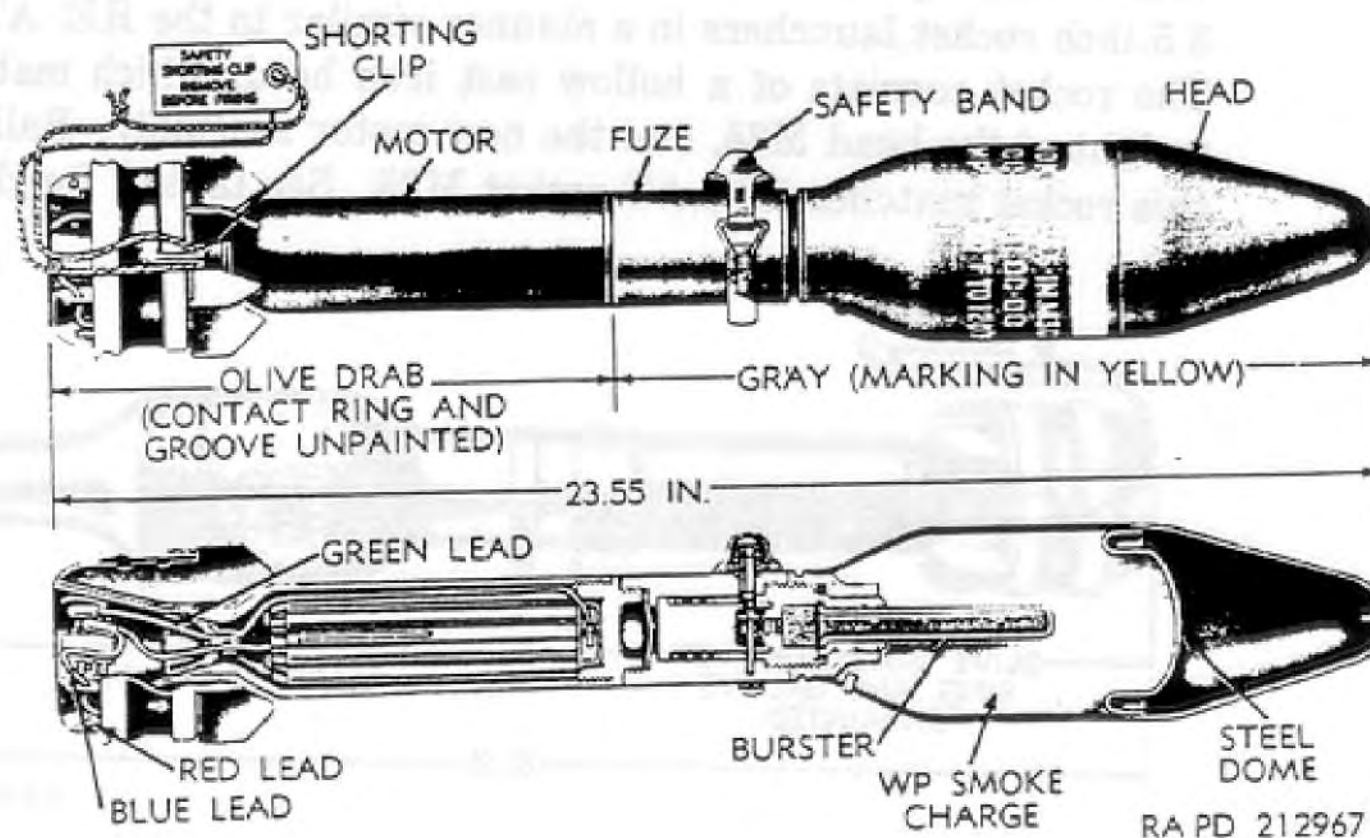


Figure 18. Rocket, smoke. 3.5-inch: WP, M30 (T127E3).

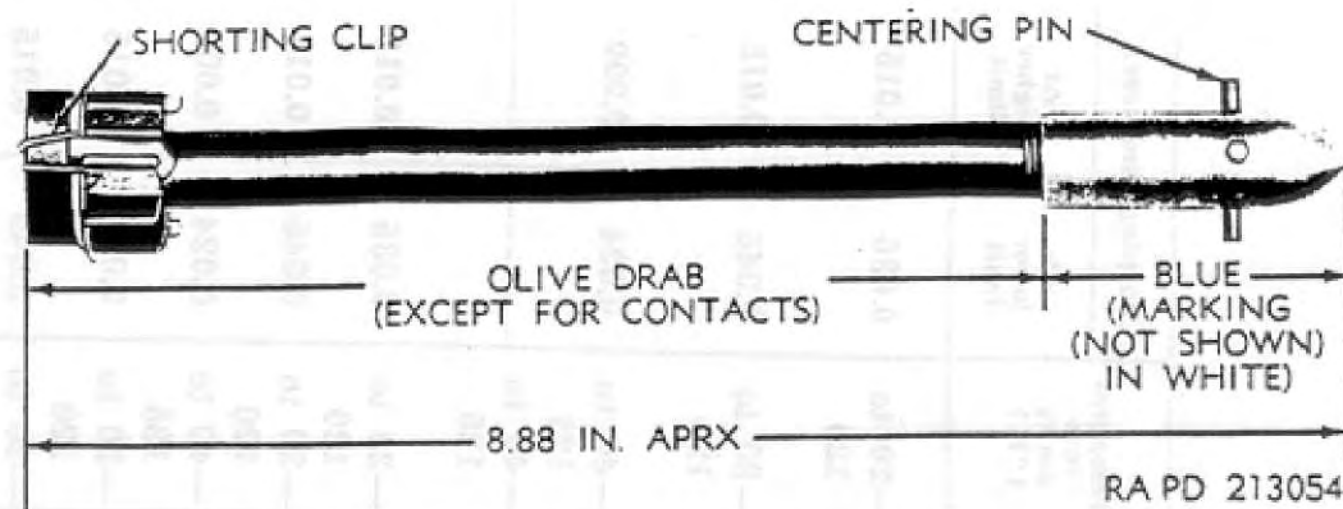


Figure 19. Rocket, subcaliber, 27 millimeter: practice, T265.

section of 27-mm subcaliber rocket launcher T144 in the bore. Firing this rocket simulates firing of the HE, AT rocket M35, since this rocket matches the rocket M35 ballistically and since the firing mechanism of the 3.5-inch launcher is used. This rocket is used for economy reasons to save wear on the 3.5-inch launcher and to expend a cheaper rocket during practice. See table I for data.

Table I. 3.5-Inch Rocket Data

Rocket nomenclature	Length (in.)	Weight (lb)	Head filler		Weight of propellant (lb)	Fuze	Velocity (fps)	Range (yds)	Temperature limits (°F.)	Burning time (sec)	
			Type	Weight (lb)						At lower limit	At higher limit
Rocket, high-explosive, 3.5- inch: AT, M28 (T80E2).	23.6	8.9	Comp B	1.93	0.36	M404 or M404A1	334	945	-20 to 120	0.035	0.015
Rocket, high-explosive, 3.5- inch: AT, M28A2.	23.6	9.02	Comp B	1.90	0.35	M404A1 or M404A2	317	945	-30 to 120	0.045	0.015
Rocket, high-explosive, 3.5- inch: AT, M35 (T205E1).	23.5	7.3	Comp B	1.60	0.44	M408	485	1300	-40 to 125	0.024	0.009
Rocket, high-explosive, 3.5- inch: AT, M35A1 (T205E- 3).	23.5	7.6	Comp B	1.70	0.44	M408E1			-40 to 125		
Rocket, practice, 3.5-inch: M29A1.	23.6	8.9	Inert	Empty ¹	0.36	M405	334	945	-20 to 120	0.035	0.015
Rocket, practice, 3.5-inch: M29A2.	23.6	8.96 ²	Inert	Empty ¹	0.35	M405	317	945	-30 to 120	0.045	0.015
Rocket, practice, 3.5-inch: M36 (T206E1).	23.5	7.3	(³)	(³)	0.44 ³	(³)	485	1300	-40 to 125	0.024	0.009
Rocket, smoke, 3.5-inch: T- 127E2.	23.6	8.98	Smoke (WP)	2.23	0.36	M404A1	317	945	-20 to 120	0.035	0.015
Rocket, smoke, 3.5-inch: M30 (T127E3).	23.6	8.98	Smoke (WP)	2.23	0.35	M404A1 or M404A2	317	945	-30 to 120	0.045	0.015

5. General

A General Description. These 4.5-inch rockets (fig. 25), which are fired from multiple launcher M31 are characterized by spin stabilization. The rockets are similar to artillery projectiles having cylindrical bodies, ogival noses, and front and rear fins. Electrical contact to the rockets is made through contact rings in the base. The rocket is loaded with motor and head assembly but unfused. The fuse cavity is sealed with a plastic plug, when loaded.

3. Head. Dependent on the type of head these rockets are high-explosive (HE), practice, gas, or drill. The head is externally threaded at the base end for assembly to the motor and internally threaded at the nose end to receive the fuse. The high-explosive heads have deep fuse cavities with a supplementary charge

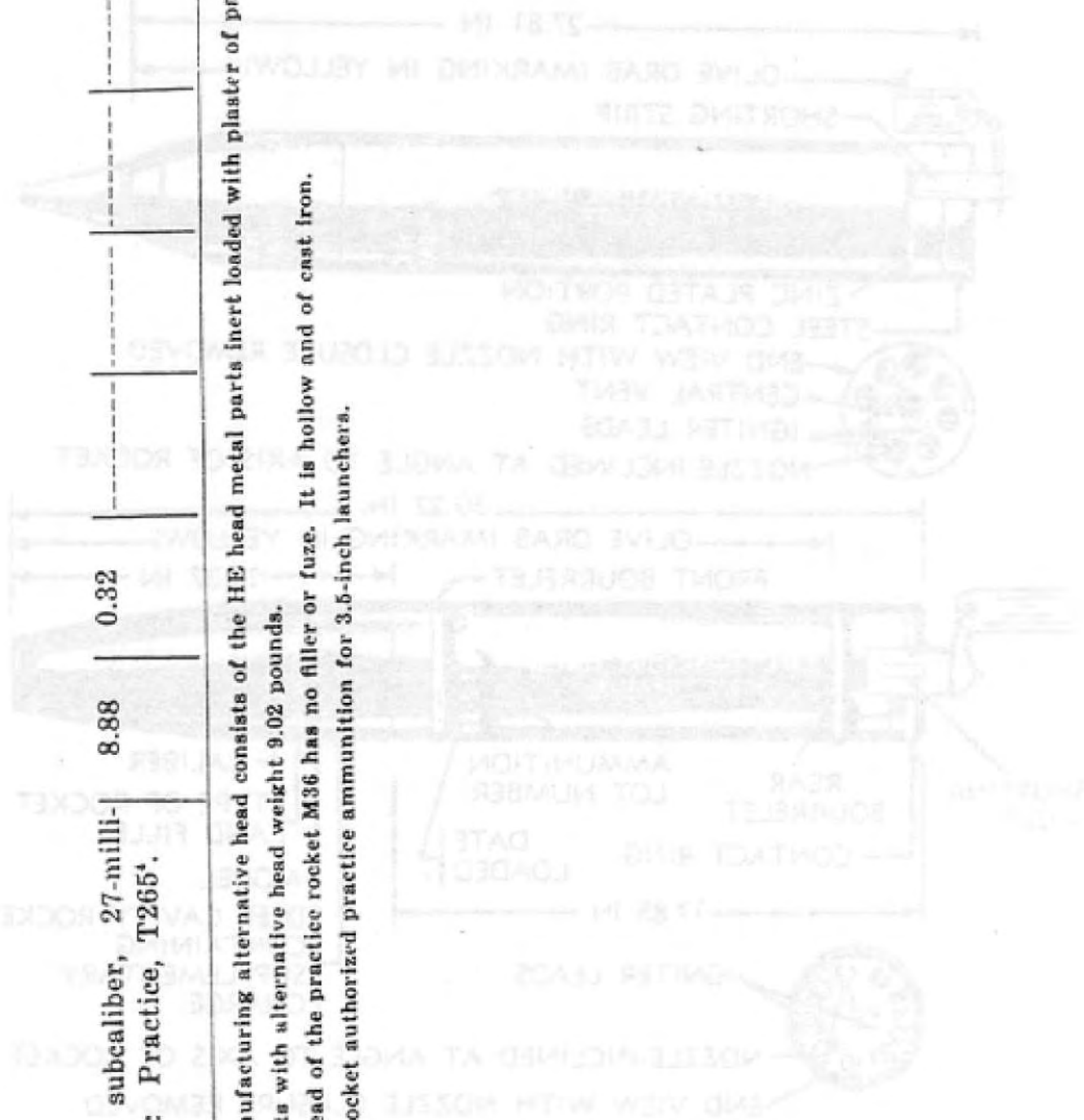
485

0.32

8.88

Rocket, subcaliber, 27-millimeter: Practice, T265⁴.

- 1 A manufacturing alternative head consists of the HE head metal parts inert loaded with plaster of paris.
- 2 Rockets with alternative head weight 9.02 pounds.
- 3 The head of the practice rocket M36 has no filler or fuze. It is hollow and of cast iron.
- 4 This rocket authorized practice ammunition for 3.5-inch launchers.

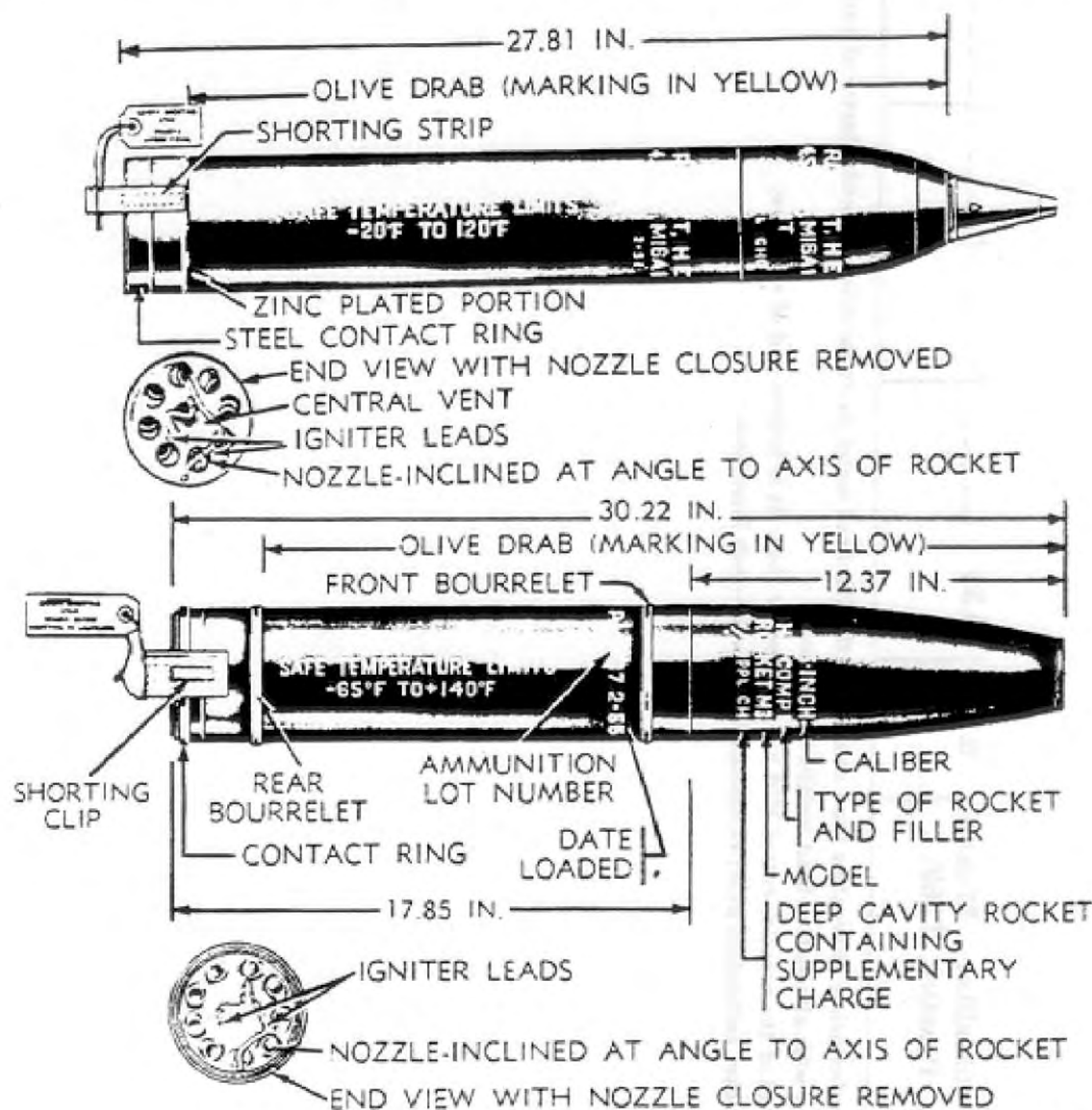


Section II. 4.5-INCH ROCKETS (FOR MULTIPLE LAUNCHER)

29. General

a. General Discussion. These 4.5-inch rockets (fig. 20), which are fired from multiple launcher M21 are characterized by spin stabilization. The rockets are similar to artillery projectiles, having cylindrical bodies, ogival noses, and front and rear bourrelets. Electrical contact to fire the rockets is made through contact rings in the base. The rocket is issued with motor and head assembled but unfuzed. The fuze cavity is sealed with a plastic closure, when issued.

b. Head. Dependent on the type of head these rockets are high-explosive (HE), practice, gas, or drill. The head is externally threaded at the base end for assembly to the motor and internally threaded at the nose end to receive the fuze. The high-explosive heads have deep fuze cavities with a supplementary charge



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Figure 20. 4.5-inch rockets.

for the point detonating fuzes. If a VT fuze is used, the supplementary charge is removed.

c. *Motor.* The motor (fig. 21) is a cylindrical steel tube threaded at one end for assembly to the head and at the other for assembly of the nozzle plate-trap assembly. It contains the propelling charge and the igniter. The nozzle plate-trap assembly (for rockets M32, M33, and T164E1) is a thick steel plug having nine equally spaced nozzles and a trap attached to its forward surface. The nozzles are inclined at an angle to impart spin as well as forward thrust. In rockets of earlier manufacture (M16 series and M17 series) the nozzle plate is a plug having eight nozzles located near the outer edge and a control vent closed by a safety blowout plug designed to blow out when the motor pressure exceeds the safe limit. A contact ring is secured to the outer surface of the nozzle plate and insulated from the nozzle plate. One lead from the igniter is connected to the contact ring and the other lead is connected to nozzle plate and thus to the motor body. A copper shorting strip or clip is taped to the outer surface of the motor connecting (shorting) the contact ring and the motor body. A disk-shaped plastic closure cemented at the end of the nozzle plate seals the motor against moisture. The motor of the rockets M32, M33, and T164E1 have front and rear bourrelets which serve as bearing surfaces for the travel of the rocket through the launcher.

(1) *Propelling charge.* Two types of propelling charge are used with these rockets.

(a) *For 4.5-inch rockets M16 (series) and M17 (series).* The propelling charge consists of 30 sticks of double base extruded propellant mounted on the wires of a cage-like support. The support consists of ten wires attached to a base ring and an annular plate which is slotted to receive the top ends of the wires. The plate rests on a seat formed by a shoulder in the forward end of the motor body.

(b) *For 4.5-inch rockets M32, M33, and T164E1.* The propelling charge consists of seven single perforated cylindrical sticks of double base extruded propellant weighing 7.78 pounds. The sticks are taped together and positioned in the motor against the trap with one central stick and six sticks surrounding it. Seven plastic propellant rods are positioned in the propellant sticks one in each perforation. See paragraph 95.

(2) *Igniter.* Two models of igniter are used.

(a) *For rockets M16 (series) and M17 (series).* The rockets M16 (series) and M17 (series) use the sus-

pended igniter M18 or M18A1 which is similar to the igniter M36. They differ principally in the type of squib and weight of black powder charge.

(b) *For rockets M32, M33, and T164E1.* The rockets HE M32, practice M33, and gas T164E1 use the igniter M36, a sealed plastic tube containing 25.0 grams of black powder and an electric squib.

d. *Fuze.* The artillery-type point detonating nose fuze M81 or M81A1 is authorized for use with high-explosive rockets. Dummy fuze M73 is authorized for use with the practice and drill rockets. VT fuze M402, M402A1, M402A2, or M402A3 is approved for use with HE rocket M32 and HE rockets M16 (series) having deep cavities. See paragraphs 41 through 55 for detailed fuze description.

e. *Identification.* These rockets are distinguished by their shape, similar to that of artillery projectiles. They have ogival nose, square base, and front and rear bourrelets.

f. *Packing and Shipping.* These rockets are packed individually in fiber containers, either one fiber container per metal container or two fiber containers per wooden box. Packing and shipping data appear in SM 9-5-1340.

g. *Preparation for Firing.* These rockets are prepared for firing as follows:

- (1) Remove from packing and inspect for serviceability. Should the plastic closing disk be loose or damaged, and evidence found of moisture corrosion which would adversely affect the igniter or propellant, the rocket should be disposed of as unserviceable.

Note. Should it be considered necessary to test the circuit continuity, test with the circuit continuity tester (par. 14).

- (2) Remove nose plug and assemble fuze. Tighten with fuze wrench. Some models may have a setscrew in the fuze adapter. In this case, the setscrew should be loosened to remove the nose plug and tightened after assembly of the fuze.
- (3) Set fuze for desired action (par. 45).
- (4) Remove the shorting strip or clip from the base of the rocket before loading it into the launcher.
- (5) If the rocket is prepared for firing and not fired, both rocket and fuze should be restored to their original condition and packings and marked for prior use in order that opened packages be kept to a minimum.

30. Rocket, Inert, 4.5-Inch: M24

This rocket is provided for training in handling and operation.

It is made up of the metal parts of the M16 rocket modified for training purposes. The modification consists of loading the motor with wooden sticks to simulate propellant powder sticks, filling the head with inert material, and fitting it with dummy fuze M73 which simulates the service fuzes of the M81 series. The total weight is approximately the same as the M16 complete round. The igniter is omitted and, in order to simulate firing operations visibly, an indicator light is installed in the nozzle plate at the rear of the rocket. The light glows when the firing switch on the launcher is closed, thus simulating the firing of the rocket, and may be seen through a plastic window which is attached to the nozzle plate.

31. Rocket, Gas, 4.5-Inch: T164E1

This is a spin stabilized gas rocket similar in external contour to the high-explosive rocket M32 described in paragraph 34. Front and rear bourrelets on the motor provide bearing surfaces for the travel of the rocket through the launcher. It consists of the same motor utilized by the high-explosive rocket M32 and a head which differs principally from the rocket M32 in having an axial burster extending the length of the cavity and seating in a support in the base of the cavity.

32. Rocket, High-Explosive, 4.5-inch: M16

This rocket is similar to the high-explosive rocket M16A1 described in paragraph 33. It differs principally from the rocket M16A1 in its shallow fuze cavity and in the presence of a burster tube of explosive extending from the base of the head into the motor. This round is loaded with 5.1 pounds of TNT and weighs 42.5 pounds.

33. Rocket, High-Explosive, 4.5-Inch: M16A1

a. *General.* This rocket is composition B loaded (early manufacture TNT) and has a deep fuze cavity with supplementary charge in place. With supplementary charge removed, this rocket is adapted for use with VT fuze of the M402 series. With supplementary charge in place, PD fuze M81A1 or M48A2 with booster M21A1 is fitted to this rocket. This rocket differs principally from the HE rocket M32 (fig. 20) in its shorter length, absence of front and rear bourrelets, and lesser weight of explosive. The rocket has a steel plug in the base of the head where the burster tube was removed in the modification of the earlier rocket M16.

b. *Data.*

Length, unfuzed.....	27.81 in.
Weight, fuzed.....	40.11 lb
Range, maximum.....	6,000 yd

Velocity, maximum.....	940 fps
Temperature limits.....	-20° F. to 120° F.
Burning time	
-20° F.....	0.34 sec
120° F.....	0.10 sec
Burnout point (ft from launcher).....	80 ft
Weight of HE filler (including suppl chg).....	4.0 lb
Weight of propellant.....	4.81 lb

34. Rocket, High-Explosive, 4.5-Inch: M32

a. General. This rocket (fig. 21) provides greater maximum range, improved accuracy, and greater lethality than the earlier HE rockets of the M16 series. The rocket is spin stabilized and has a relatively thin-walled high-explosive head designed for blast effect. Front and rear bourrelets on the cylindrical rocket motor provide bearing surfaces for the travel of the rocket through the launcher. This rocket is issued unfuzed with a plastic nose plug in lieu of fuze and with a supplementary charge in place. With supplementary charge in place, the rocket is adapted for point detonating fuze M81 or M81A1. With supplementary charge removed, the rocket can accommodate VT fuze M402, or M402A1.

b. Data.

Length (unfuzed).....	30.22 in.
Weight (as fired).....	42.0 lb
Range (at 45° elevation).....	9,100 yd
Velocity.....	1,250 fps
Temperature limits.....	-65° F. to 140° F.
Burning time	
-65° F.....	0.95 sec
140° F.....	0.35 sec
Weight of high-explosive filler.....	6.1 lb
Weight of propellant.....	7.78 lb

35. Rocket, Practice, 4.5-Inch: M17

This inert-loaded rocket is similar to the rocket described in paragraph 36. It differs principally in the presence of a burster tube filled with inert material attached to the base of the head and extending into the motor.

36. Rocket, Practice, 4.5-Inch: M17A1

This rocket is similar in external contour to the high-explosive rocket M16A1 described in paragraph 33. It differs from the high-explosive rocket in the inert loaded head, the shallow fuze cavity, and the dummy fuze M73. All ballistic and physical data for this rocket matches that for the high-explosive rocket M16A1.

37. Rocket, Practice, 4.5-Inch: M33

a. General. This rocket (fig. 22) has the same external contour

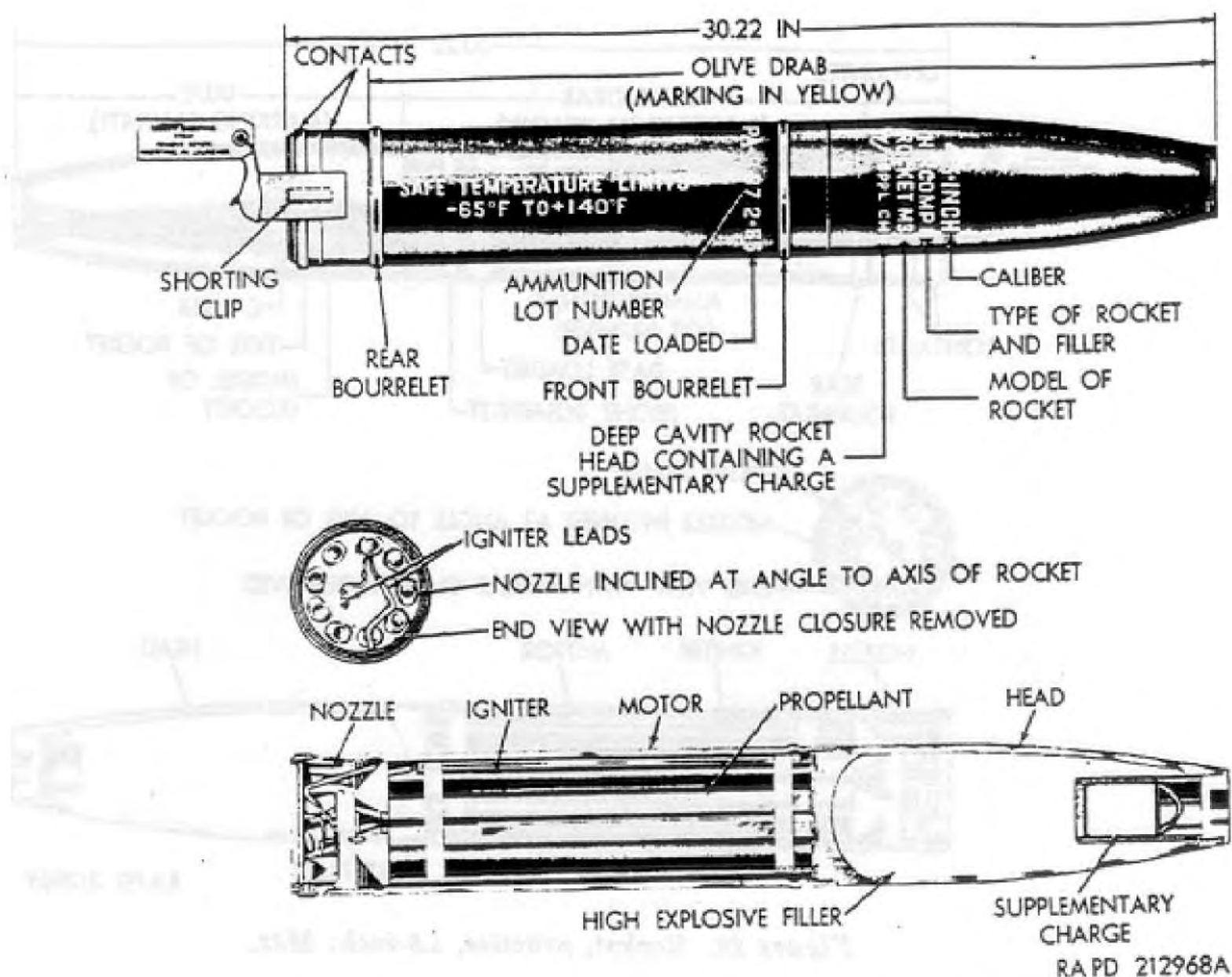


Figure 21. Rocket, high-explosive, 4.5-inch: M32.

as the high-explosive rocket M32 (par. 34). It differs principally from the HE rocket M32 in the shallow fuze cavity (no supplementary charge) and the inert filler which matches the weight of the high-explosive filler and supplementary charge. Inert fuze M73 is fitted to the nose of this rocket.

b. Data.

Length, unfuzed	30.22 in.
Weight, as fired	42.0 lb
Range, maximum (at 45° elevation)	9,100 yd
Velocity	1,250 fps
Temperature limits	-65° F. to 140° F.
Burning time	
-65° F.	0.95 sec
140° F.	0.35 sec
Weight of propellant	7.78 lb

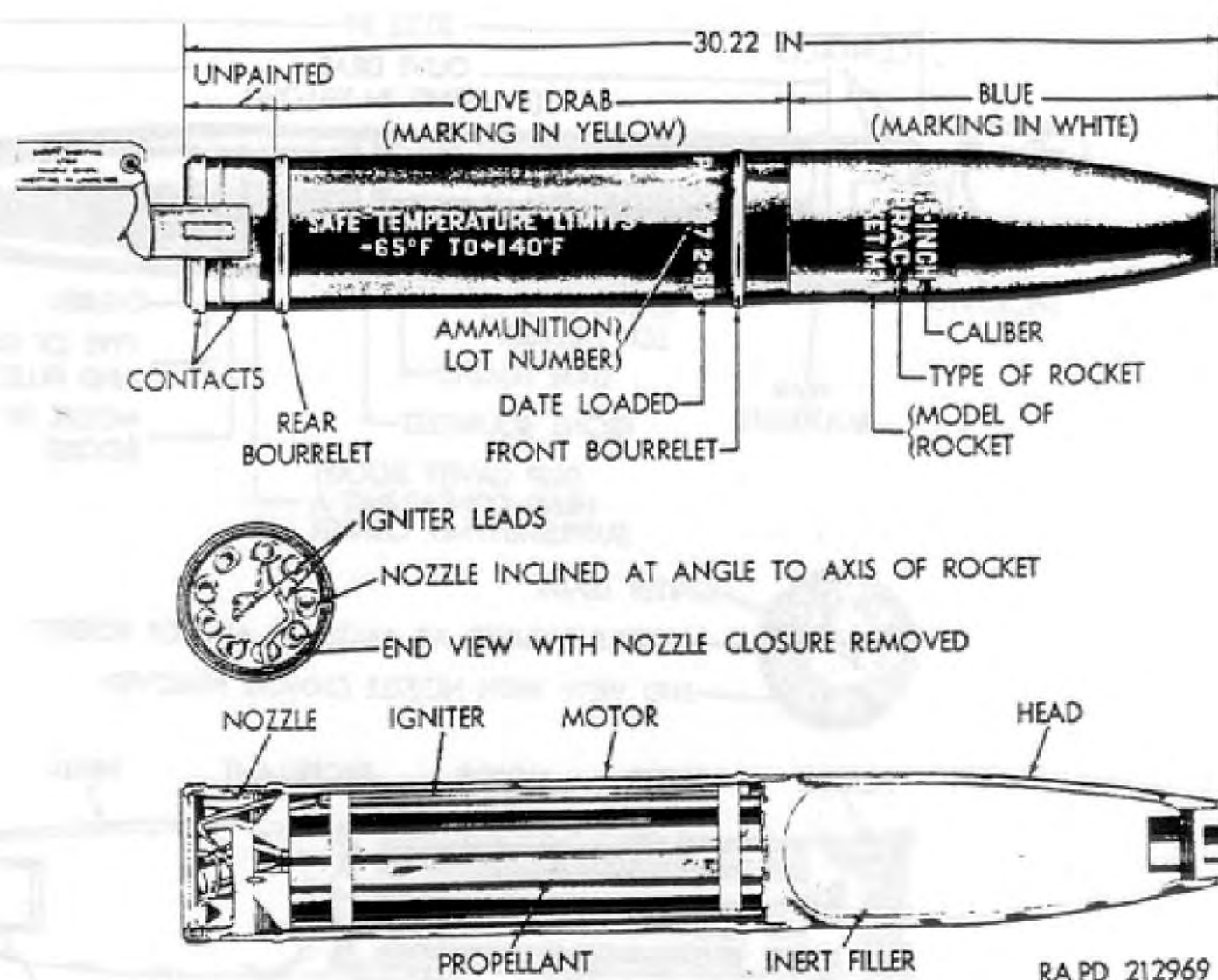


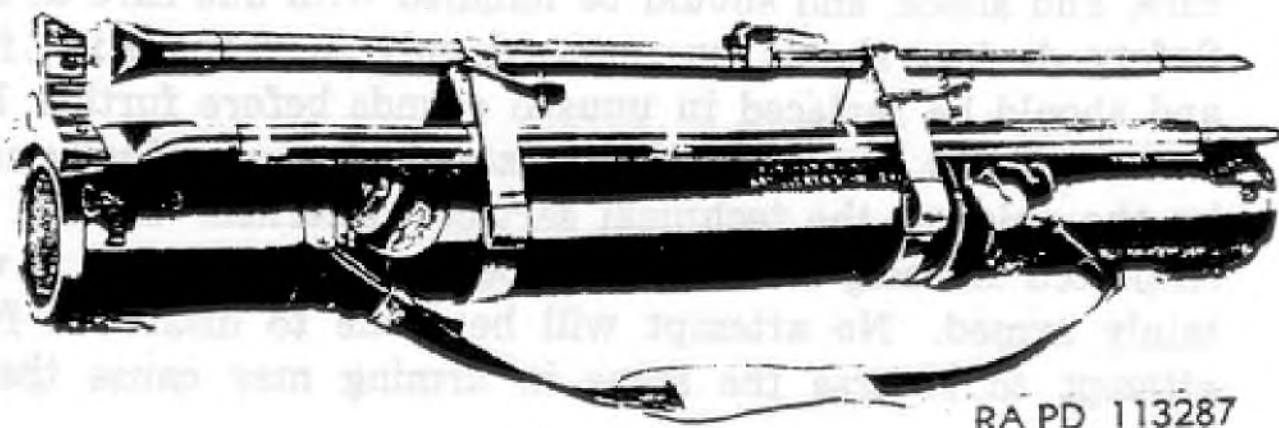
Figure 22. Rocket, practice, 4.5-inch: M38.

Section III. 4.5-INCH ROCKETS (FOR EXPENDABLE-TYPE LAUNCHER)

38. General

a. *General Discussion.* These rockets of the M20 and M21 series are spin stabilized similar to the 4.5-inch rockets of the M16 and M17 series described in paragraphs 29 through 37 except that they are fired from expendable rocket launchers M12A1 and M12A2. The principal external difference between the types of rocket is derived from the method of firing. In those for the multiple-type launchers described in paragraphs 29 through 37, the igniter lead wires are connected to the contact rings at the base of the rocket (figs. 5 and 20); those for the expendable-type launchers have the igniter wires brought out through a nozzle (fig. 5) and connected to long exterior wires which are wound around the rear spacer. The long exterior lead wires are unwound to permit firing the rockets from a remote point.

b. *Packing and Shipping.* These rockets are packed and shipped in the expendable launcher (fig. 23). The fuze, in a separate fiber container, is packed with the rocket in its launcher in a wooden box. Packing and shipping data for these rockets appear in SM 9-5-1340.



RA PD 113287

Figure 23. 4.5-inch rocket in expendable launcher.

39. Rocket, High-Explosive, 4.5-Inch: M20 (in Launcher, Rocket, 4.5-Inch: M12A1 or M12A2)

This rocket is similar to the 4.5-inch HE rocket M16 (par. 32). It is packed with PD fuze M81 or M48A2 with booster M21A1.

40. Rocket, Practice, 4.5-Inch: M21 (in Launcher, Rocket, 4.5-Inch: M12A1 or M12A2)

This rocket is similar to the 4.5-inch practice rocket M17 (par. 35).

Section IV. TIME AND IMPACT FUZES FOR GROUND-TYPE ROCKETS

41. General

A fuze is armed when the various parts are in a position such that detonation may be initiated. For safety in shipping and handling, fuzes are kept unarmed. This may be accomplished by safety pins or wires preventing the motion of firing mechanism or by arrangement of the components so that they cannot function until moved into position by forces incident to firing. A fuze, in which the detonator is held out of line so that it cannot explode the shell until armed, is detonator safe; when this condition persists until after the round leaves the weapon, the fuze is boresafe. Various forces are employed for arming rocket fuzes. Fuzes used on fin-stabilized rockets may be armed by setback (inertia), the air resistance operating a propeller, motor pressure, cessation of acceleration, or a combination of these. Fuzes for spin-stabilized rockets usually are armed by centrifugal force. For characteristics, see paragraph 9.

Caution: Fuzes contain the most sensitive explosives used for military purposes. They are particularly susceptible to heat, mois-

ture, and shock, and should be handled with due care at all times. Safety devices should be removed only in preparation for firing and should be replaced in unused rounds before further handling. Fuzes will not be disassembled, except when specifically authorized by the chief of the technical service concerned. A fuze which is suspected of being armed should be handled as though it were certainly armed. No attempt will be made to disarm a fuze; any attempt to reverse the steps in arming may cause the fuze to detonate.

42. Fuze, Dummy: M73

This is an inert fuze of the same shape and weight as the fuzes of the M81 series. It is used with 4.5-inch practice rockets M17 (series), M21 (series), M33, and drill rocket M24. It consists of a hollow steel fuze body and a solid plug (simulating the booster M24). Unlike the fuze M81A1, this fuze does not provide for "superquick" or "delay" setting.

43. Fuze, PD: M48A2, SQ, 0.05-Sec Delay, W/Booster, M21A1

This fuze, which is similar to the fuze described in paragraph 45, is authorized for use with 4.5-inch high-explosive rockets and gas rocket T164E1. It consists of PD fuze M48A2 staked to the booster M21A1.

44. Fuze, PD: M81

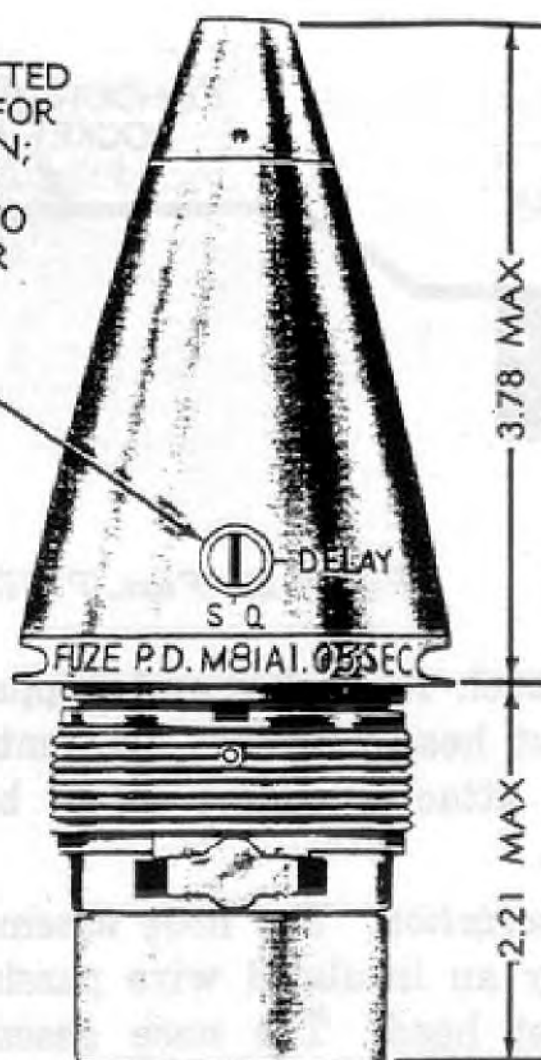
This is similar to the fuze described in paragraph 45 except that it has PD fuze M48A2 as a component. It is fitted to the nose of 4.5-inch high-explosive rockets M16 (series), M32, and gas rocket T16E1.

45. Fuze, PD: M81A1

a. General. This fuze (fig. 24) is an artillery type nose fuze with booster assembled and is used with spin-stabilized high-explosive rockets M16 (series), M21 (series), M32, and gas rocket T164E1. It is a selective superquick or delay type and arms by centrifugal force. The fuze consists of the PD fuze M48A3, SQ, 0.05-second delay staked to booster M24 or M21A1.

Warning: The only conventional type (other than VT) fuzes authorized for use with 4.5-inch rockets M16 (series), M20 (series), M32, and T160E1 are the M81A1, M81, and M48A2 with booster M21A1. No fuze boosted with booster M21A2 or M21A4 will be used in connection with the fuzing of 4.5-inch spin-stabilized rockets because the setback force developed when firing these rockets is insufficient to arm the boosters.

SETTING SLEEVE SLOTTED
AS INDICATED, SET FOR
SUPERQUICK ACTION;
AT RIGHT ANGLE
(PERPENDICULAR) TO
AXIS OF FUZE FOR
DELAY ACTION



RA PD 65211B

Figure 24. Fuze, PD: M81A1.

b. *Description.* The fuze is a standard contour artillery fuze with booster assembled. The slot of the setting sleeve is parallel to the axis of the fuze when set "superquick" and perpendicular to the axis when set for "delay" action. Booster M21A1 differs from the booster M24 illustrated, in that it has a safety cotter pin with a pull ring which must be removed before assembling the fuze to the rocket, and replaced if the rocket is unfuzed. The components and functioning of this fuze are similar to those of fuzes M51 series described and illustrated in TM 9-1901.

c. *Fuzing.* Remove the fuze from the packing and inspect it. Inspect the fuze cavity of the rocket for the presence of the supplementary charge. Set the fuze for the desired action and thread into the adapter. Tighten the fuze and adapter setscrew.

46. Fuze, PIBD: M408 (T2030E4)

a. *General.* This fuze (fig. 25) consists of a nose assembly crimped to the forward end of the rocket head, and a base assembly contained in the rear end of the rocket head. The fuze is designed to function by either impact or graze. The impact action of the fuze is derived from the piezoelectric effect which is the tendency of certain crystals to generate a minute electric current when stressed. The fuze is boresafe and arms after 20 to 35 feet of

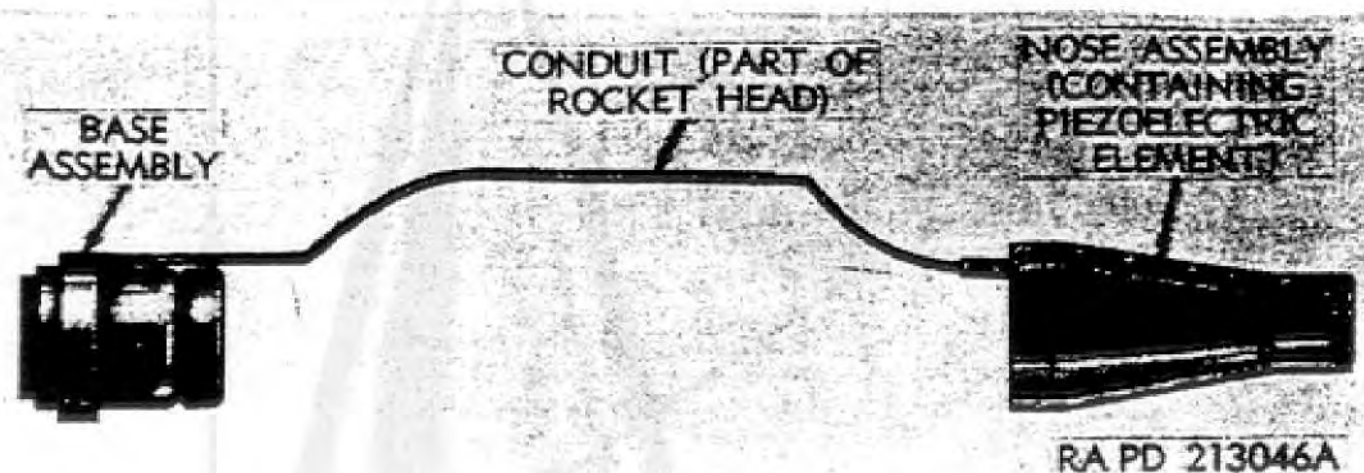


Figure 25. Fuze, PIBD: M408 (T2030E4).

rocket travel. As packed and shipped, the safety band fitting around the rocket head prevents accidental functioning of the fuze, due to a pin, attached to the safety band, passing through the cover assembly.

b. Description. The nose assembly is connected to the base assembly by an insulated wire passing through a copper conduit in the rocket head. The nose assembly consists essentially of an aluminum cone containing a piezoelectric crystal. The front face of the crystal is grounded to the body of the rocket through the aluminum cone and the rear face is connected to a detonator in the base assembly. The base assembly consists of a body containing a delay arming mechanism, detonator M48, a tetryl lead, and a graze firing mechanism consisting essentially of a spring-loaded firing pin, primer M26, and a lead azide relay.

c. Functioning. After the safety band has been removed, the fuze is free to arm when subjected to setback forces equivalent to rocket functioning. The delay arming mechanism holds the detonator out of line with respect to the tetryl lead and booster. Setback force, incident to firing, actuates the delay arming mechanism which aligns the detonator after 20 to 35 feet of rocket travel. Impact of the target compresses the crystal, in the nose of the rocket, generating the surge of electricity which detonates the detonator initiating the high-explosive train of the rocket. If impact is insufficient to actuate the crystal, as in graze or when the rocket strikes a soft target such as soft terrain, the graze mechanism functions to initiate the fuze and fire the rocket. Deceleration triggers the spring-loaded firing pin which fires the primer initiating the lead azide relay firing the detonator.

47. Fuze, PIBD: M408E1

This fuze is a point initiating, base detonating type for use with 3.5-inch rocket M35A1 and functions in the same manner as fuze M408 (par. 46).

48. Fuze, Rocket, BD: M404

This fuze is similar to the BD fuze M404A2 described in paragraph 50. It differs principally in minor design changes of the functioning parts and the shape of the safety band.

49. Fuze, Rocket, BD: M404A1

This fuze is similar to the BD fuze M404A2 described in paragraph 50. It differs principally in minor design changes of the functioning parts and the shape of the safety band.

50. Fuze, Rocket, BD: M404A2

This fuze (figs. 26 and 27) consists of a body (J) which contains the functioning parts, a safety band (C), a detonator (N), and a booster pellet (P). Being externally threaded at the forward end and internally threaded at rear end, it serves as a coupling between the head and motor of 3.5-inch HE, AT and smoke rockets.

a. Description. The fuze is of the simple inertia (setback arming) type which functions with nondelay action on impact. The fuze mechanism (fig. 27) consists of an activating plunger (G), a setback spring (F), a setback sleeve (E), a firing pin assembly (M), a detent (L), a detent spring (K), an ejection pin (D), and an ejection spring (B). The safety band restrains outward movement of the spring-loaded ejection pin, which passes through the fuze body, preventing movement of the internal parts and thus preventing accidental functioning during shipping and handling. The fuze body and safety band are olive drab. The fuze nomenclature, the loader's lot number, and the month and year of loading are stamped into the metal.

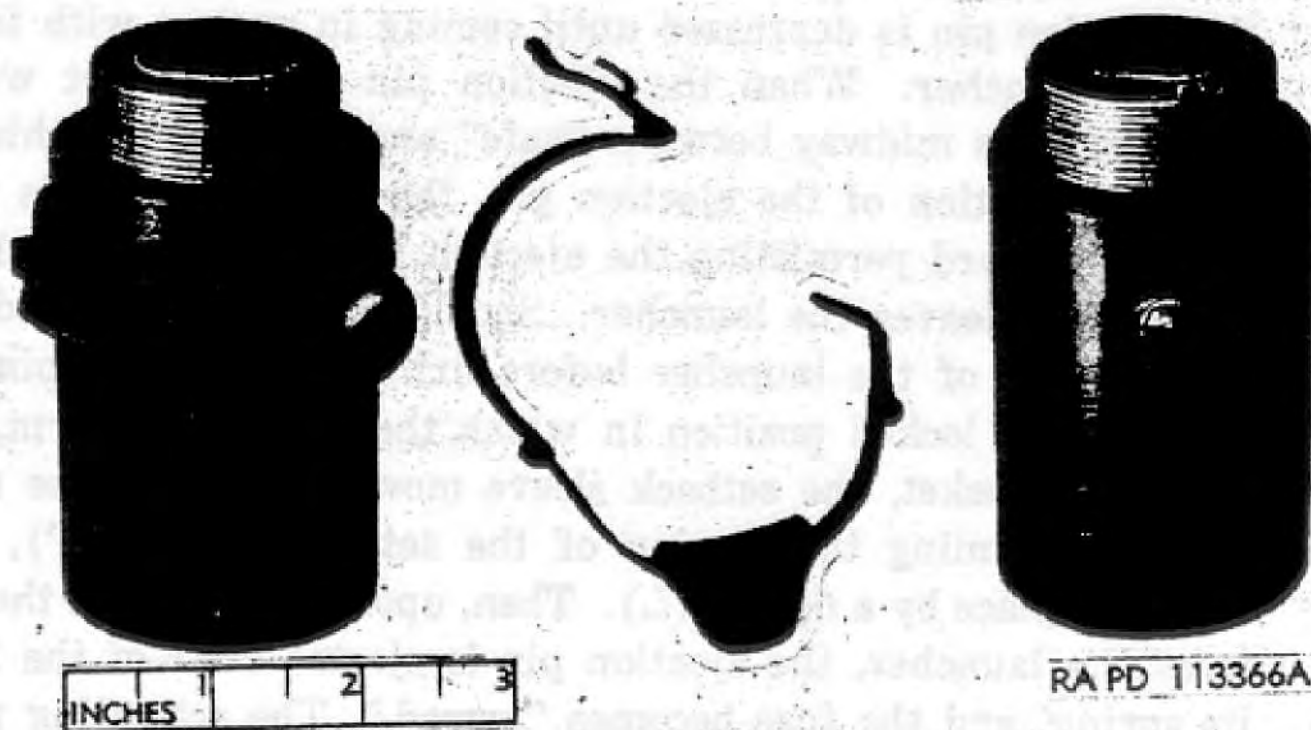


Figure 26. Fuze, rocket, BD: M404A2—as issued and with safety band off.

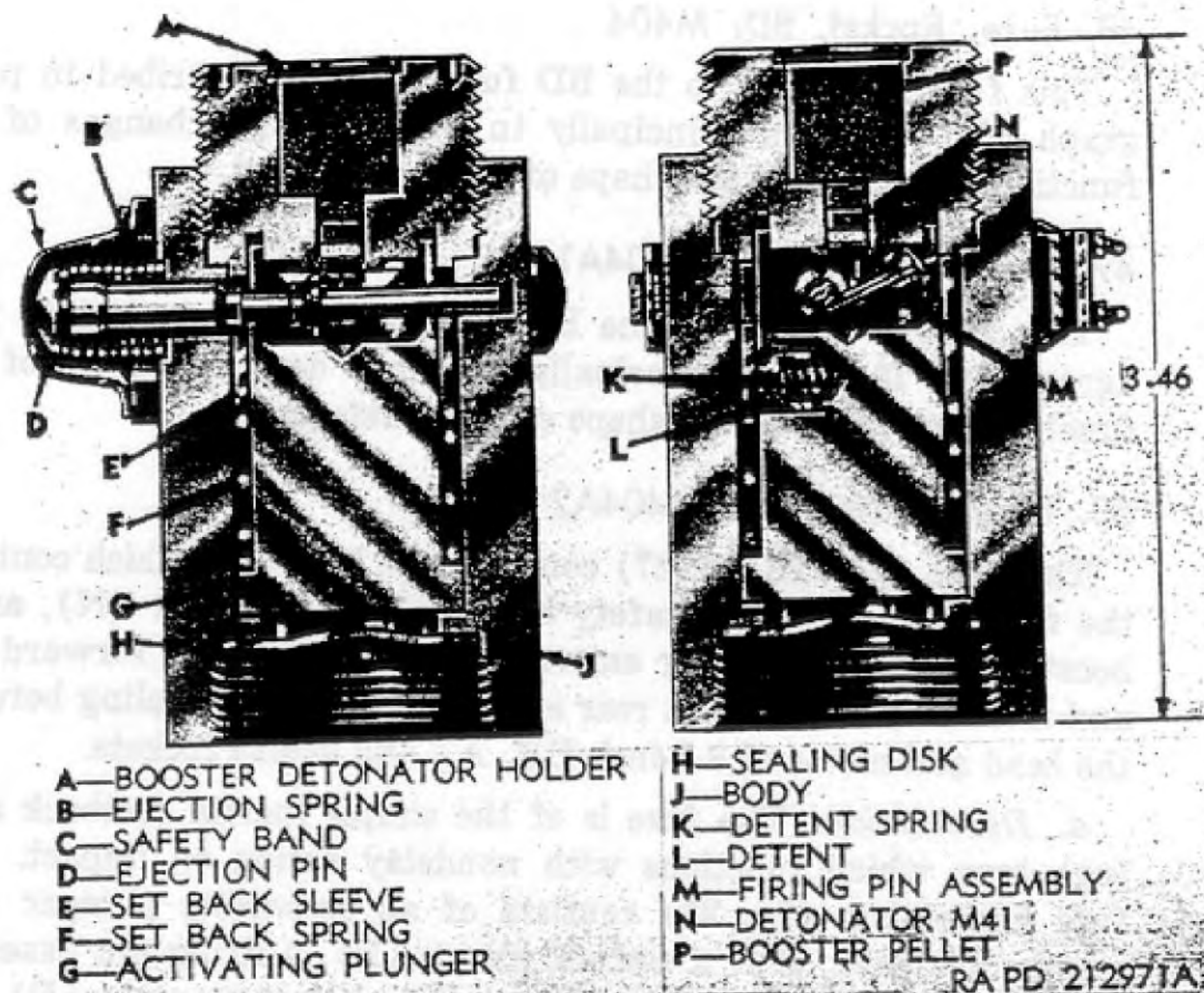


Figure 27. Fuze, rocket, BD: M404A2—cross-section.

b. *Functioning.* The ejection pin (D) is held in the "safe" position by the safety band (C). When this is removed, the ejection pin is moved about $\frac{3}{8}$ -inch outward by its spring (B), in which position it is held by the setback sleeve (E). This is the "locked" position. The fuze cannot arm with the ejection pin in either the "safe" or "locked" position. When the rocket is loaded in the launcher, the ejection pin is depressed until coming in contact with the bore of the launcher. When the ejection pin is in contact with the launcher it is midway between "safe" and "locked." In this intermediate position of the ejection pin, the setback sleeve is free to move backward permitting the ejection pin to be ejected when the fired rocket leaves the launcher. Should the rocket be accidentally dropped out of the launcher before firing, the ejection pin would move to the locked position in which the fuze cannot arm. Upon firing the rocket, the setback sleeve moves rearward, the setback force overcoming the tension of the setback spring (F), and is locked in place by a detent (L). Then, upon emergence of the rocket from the launcher, the ejection pin is ejected clear of the fuze by its spring, and the fuze becomes "armed." The activating plunger (G) is prevented from "creeping" forward in flight by the tension

of the firing pin spring which compresses before initiating the functioning of the firing pin assembly. Upon impact, normal or graze, the activating plunger moves forward, overcoming the initial restraint of the firing pin spring and triggering the lever action of the firing pin assembly (M). This drives the firing pin into the detonator (N), and explodes the rocket. Due to the shape of the plunger and the spring and lever action of the firing pin assembly, the fuze is rapid in action and sensitive to low angle graze impacts.

c. Precautions. See paragraph 18h for special fuze precautions while preparing the rocket for firing and while loading the rocket in the launcher.

51. Fuze, Rocket, Dummy: M405

The dummy fuze M405 is in an inert fuze similar in appearance to the BD fuze M404A2 described in paragraph 50. It simulates the handling and pin ejection of the BD M404A2 fuze with a double-locking, bore-riding, round ejection pin and a safety band which is removed prior to firing. It is used with 3.5-inch practice rockets M29A1 and M29A2. During drill with the practice rocket which has this fuze, the same procedure should be followed as in paragraph 18h.

Section V. VT FUZES FOR GROUND-TYPE ROCKETS

52. General

For general description of VT fuzes, see paragraph 9.

53. Fuze, Rocket, VT: M402

a. General. The VT fuze M402 (fig. 28) is a proximity fuze for ground-to-ground use in the spin-stabilized 4.5-inch rockets M16A1, M16A2, M32 (T160E5), M20E1, and M20E2. This fuze is, in effect, an automatically set time fuze. Without field adjustment, it produces an air burst at a height to cause greatest lethal fragmentation effect against personnel without top cover such as men in foxholes. The VT fuze M402 can only be assembled to rockets having a deep fuze cavity (fig. 29) due to the fact that its added length to the rear of the fuze threads requires more space. Rockets with deep fuze cavity are provided with a supplementary charge to adapt them for use with conventional point detonating fuzes M81A1 or M81. When using the VT fuze, the supplementary charge must be removed. Forward of the fuze threads, the VT fuze presents the same contour as the PD fuze and, as a result, rockets fuzed with VT or PD fuze have the same overall shape. Also, the weight of the VT fuze is equal to the weight of PD fuze and supplementary

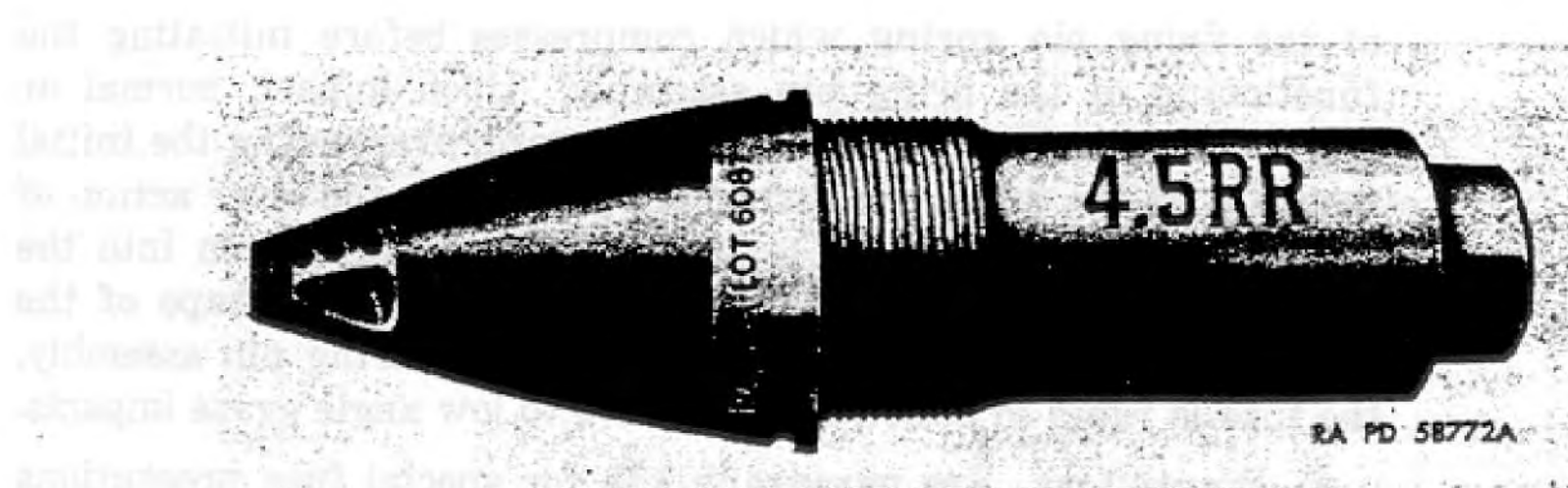


Figure 28. Fuze, rocket, VT: M402.



Figure 29. Rocket, high-explosive, 4.5-inch: M32 (T160E5) with fuze rocket VT: M402.

charge, resulting in rockets with VT fuze matching rockets with PD fuze ballistically.

b. Characteristics of Fuze.

- (1) *Arming.* Arming of these fuzes is delayed for at least 4.0 seconds after being fired. The exact time of arming will vary within the range of approximately 4.0 to 8.0 seconds. Arming is delayed by a series of safety devices which depend on rocket rotation.
- (2) *Burst height.*
 - (a) The height of burst varies with the angle of fire, thus maintaining nearly optimum burst height at all ranges over average level ground (fig. 30). The height of burst over a body of water will be approximately twice that over land, and will be greater over wet soil or soil containing metal fragments than over dry soil.
 - (b) Burst height dispersion normally will not vary from the average (fig. 30) by more than 50 percent. The dispersion in height of burst decreases as the time of flight increases.
 - (c) Light tree foliage and vegetation do not materially affect the height of burst, but dense tree foliage and thick vegetation will increase the height of burst over ground. This effect is less at steeper angles of fires in which case, most bursts will occur slightly below tree top level.

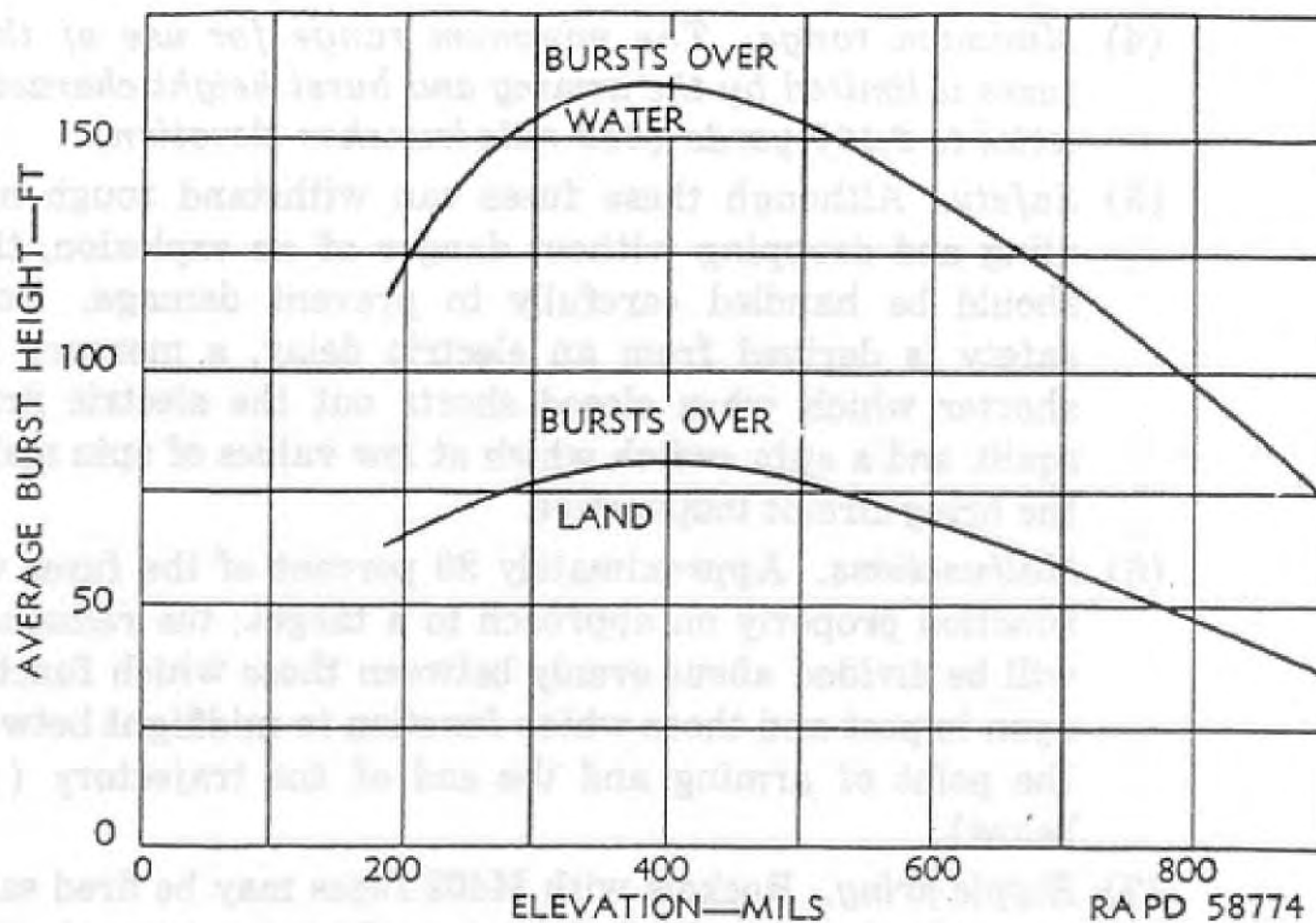
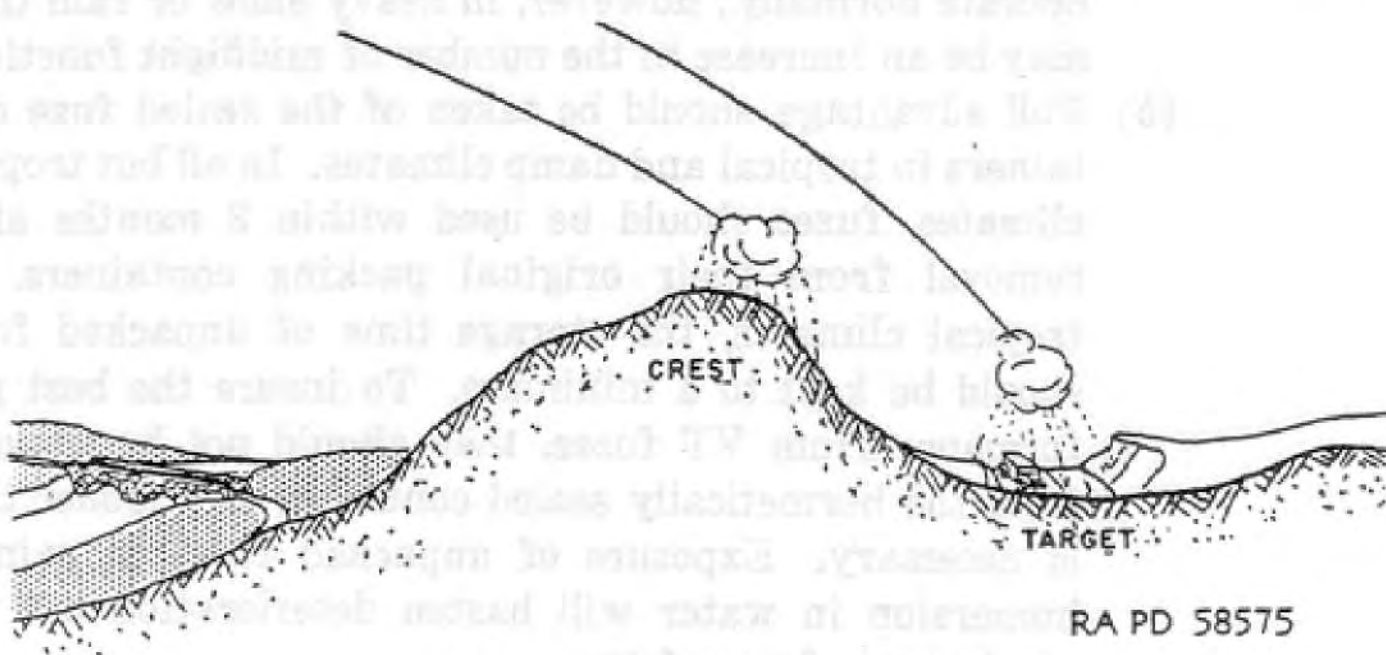


Figure 30. Burst height as compared with launcher elevation.

(d) Close passage or approach to crests, trees, streams, towers, parked aircraft, mechanized equipment, etc., will cause functions at heights greater than indicated in figure 30. This characteristic may be used to advantage, in that fire power will tend to be concentrated on such irregularities. When targets are beyond such irregularities, clearance of at least 250 feet should be allowed to insure maximum effect over the target area (fig. 31).

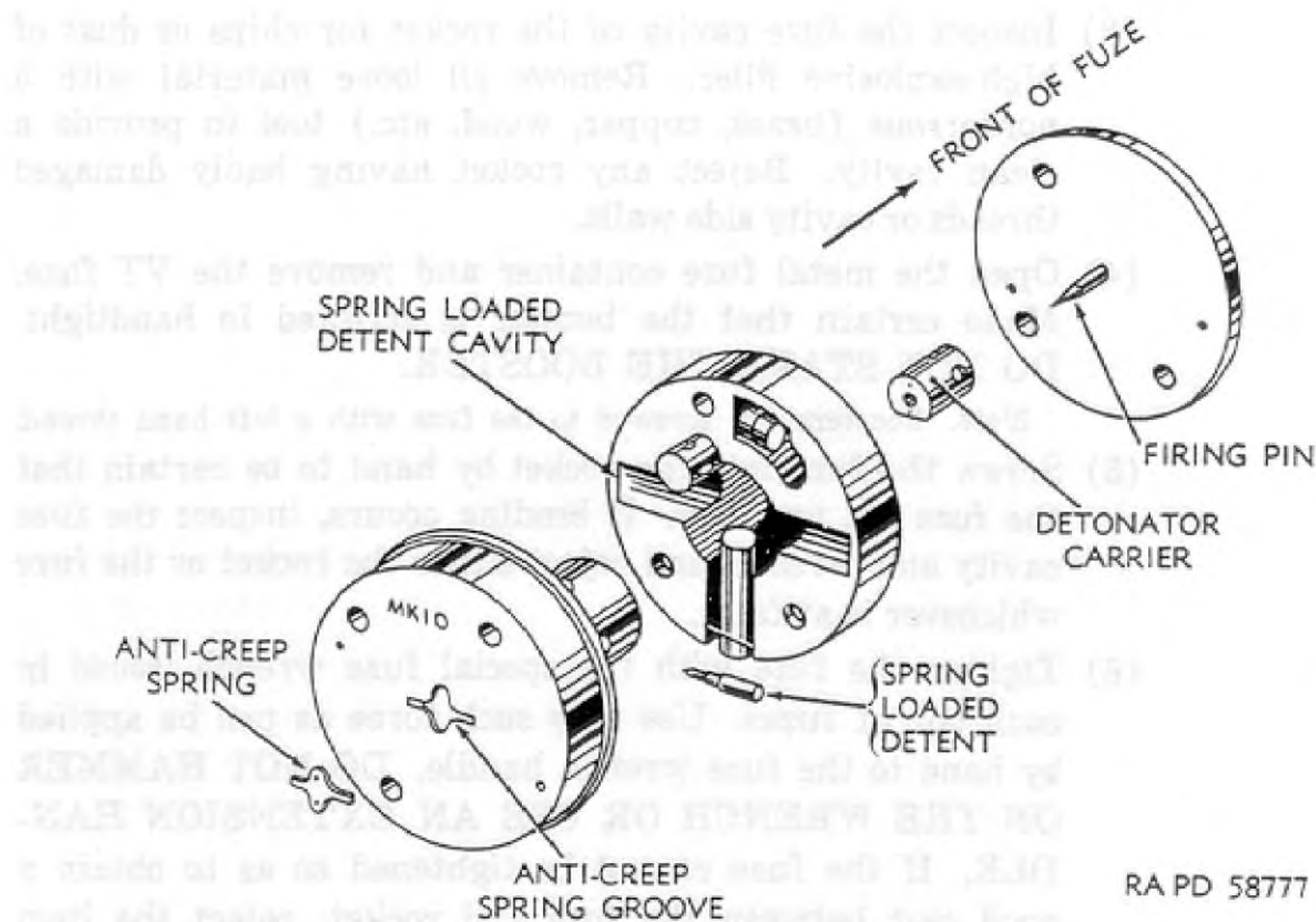
(3) *Danger to aircraft.* Aircraft will cause armed fuzes to function if the rocket passes within 30 feet of the craft.



ADEQUATE CLEARANCE IS REQUIRED TO
AVOID WASTING ROUNDS ON CREST.

Figure 31. Adequate clearance.

- (4) *Minimum range.* The minimum range for use of these fuzes is limited by the arming and burst height characteristics to 2,400 yards (212 mils launcher elevation).
- (5) *Safety.* Although these fuzes can withstand rough handling and dropping without danger of an explosion, they should be handled carefully to prevent damage. Bore-safety is derived from an electric delay, a mercury unshorter which when closed shorts out the electric firing squib, and a spin switch which at low values of spin makes the firing circuit inoperative.
- (6) *Malfunctions.* Approximately 80 percent of the fuzes will function properly on approach to a target; the remainder will be divided about evenly between those which function upon impact and those which function in midflight between the point of arming and the end of the trajectory ((9) below).
- (7) *Ripple firing.* Rockets with M402 fuzes may be fired satisfactorily from multiple-tube launchers at normal (0.4-sec) intervals. A slight increase in midflight functions may be observed when several multiple-tube launchers are firing simultaneously. Launchers fired simultaneously should be at least 100 feet apart.
- (8) *Impact functions.* Fuze M402A1 is equipped with a non-delay impact detonating device (fig. 32) which will function if an air burst is not produced. This reduces duds to less than 5 percent.
- (9) *Climatic effects.*
 - (a) Fuze M402A1 may be used in day or night operations with equal effect. In light precipitation, the fuze will operate normally; however, in heavy snow or rain there may be an increase in the number of midflight functions.
 - (b) Full advantage should be taken of the sealed fuze containers in tropical and damp climates. In all but tropical climates, fuzes should be used within 2 months after removal from their original packing containers. In tropical climates, the storage time of unpacked fuzes should be kept to a minimum. To insure the best performance from VT fuzes, they should not be removed from the hermetically sealed container any sooner than is necessary. Exposure of unpacked fuzes to rain or immersion in water will hasten deterioration but will not decrease fuze safety.
- (10) *Temperature.* Optimum fuze performance will be obtained when fired at temperatures between 0 and 120° F.



RA PD 58777

Figure 32. Impact detonating element.

Therefore, the fuzes should not be used outside these temperature limits. As long as the fuzes themselves are between these limits at the time of firing, they will operate even though the atmospheric temperature is outside these limits. Temporary exposure of the fuzes to temperatures outside of these limits will not permanently injure them. Prolonged exposure to temperatures outside these limits will result in increased midflight and impact functions, but will not decrease fuze safety.

54. Fuze, Rocket, VT: M402A1

The VT fuze M402A1, developed since World War II, is waterproofed at the time of manufacture and can remain outside its hermetically sealed container at least 2 years under normal conditions without undergoing any deterioration. To insure the best performance from VT fuzes, they should not be removed from the hermetically sealed container any sooner than is necessary.

55. Use and Care of VT Fuze

a. Assembly to Rocket M16A1 or M32 (T160E5).

- (1) Loosen the setscrew and remove the nose plug from the rocket with the wrench provided.
- (2) Remove the supplementary charge.

(3) Inspect the fuze cavity of the rocket for chips or dust of high-explosive filler. Remove all loose material with a nonferrous (brass, copper, wood, etc.) tool to provide a clean cavity. Reject any rocket having badly damaged threads or cavity side walls.

(4) Open the metal fuze container and remove the VT fuze. Make certain that the booster is screwed in handtight. **DO NOT STAKE THE BOOSTER.**

Note. Boosters are screwed to the fuze with a left hand thread.

(5) Screw the fuze into the rocket by hand to be certain that the fuze fits properly. If binding occurs, inspect the fuze cavity and threads, and reject either the rocket or the fuze whichever is at fault.

(6) Tighten the fuze with the special fuze wrench issued in each box of fuzes. Use only such force as can be applied by hand to the fuze wrench handle. **DO NOT HAMMER ON THE WRENCH OR USE AN EXTENSION HANDLE.** If the fuze cannot be tightened so as to obtain a good seat between the fuze and rocket, reject the item which is at fault. **DO NOT STAKE FUZE TO ROCKET.** Tighten the setscrew in the nose of the rocket.

b. Disassembly Procedure.

(1) *VT fuzes will not be disassembled under any circumstances by using arms or ordnance troops.*

(2) VT fuzes may be removed from the rocket, as occasion requires, by loosening the setscrew and unscrewing the fuze with the wrench provided with the fuzes.

c. Packing and Marking.

(1) Each fuze is packed in a hermetically sealed metal container (fig. 33) equipped with a tear strip and key for opening. Twelve of these containers are packed in a corrugated carton with a special wrench for assembling the fuze to the rocket shell. The carton is enclosed in a steel fuze box (fig. 34). Weights and dimensions of the fuze and packing box are tabulated below:

Fuze weight.....	2.7 lb
Fuze length, overall.....	8.43 in.
Fuze length, in cavity.....	4.91 in.
Box dimensions.....	14½ x 14¼ x 11¾ in.
Box weight w/fuzes and wrench.....	70.5 lb
Box volume.....	1.50 cu ft

(2) Each fuze has the model of the fuze, and the manufacturer's lot number die rolled into its nose section. The



Figure 33. Hermetically sealed container.

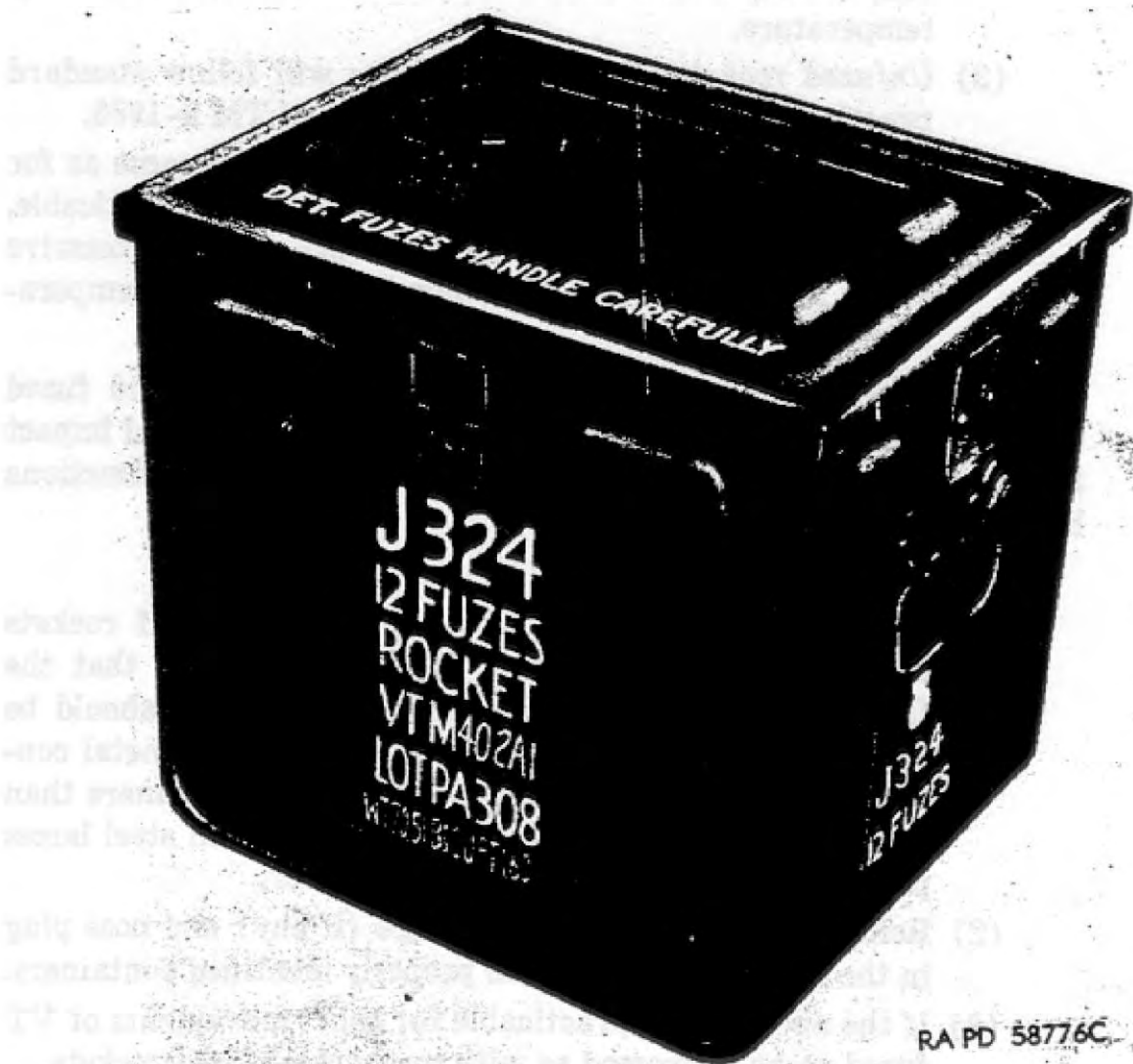


Figure 34. Packing box for VT fuzes.

identifying symbol of its application, 4.5RR, is stamped (fig. 28) in the cylindrical section of the fuze.

d. Storage.

- (1) *Fuzes.* The normal facilities available for storage of ammunition, both at the battery position and in the ammunition dumps are, in general, suitable for VT fuzes. These fuzes may be stored in their original unopened metal containers provided they receive proper security and the same care given all packed ammunition, in addition to keeping the storage temperature limits between -20 and 130° F. Storage outside of these limits for any extended interval will result in permanent damage. Fuzes, whether packed or unpacked, should be kept out of the direct rays of the sun, which is a source of heat sufficient to raise their temperature.
- (2) *Unfuzed rockets.* Storage conditions will follow standard practice, in accordance with provisions of TM 9-1903.
- (3) *Fuzed rockets.* Storage conditions will be the same as for other fuzed ammunition except that, so far as practicable, the fuzed rockets should be protected against excessive shock and exposure to high humidity and high temperatures.

e. Handling. The same care should be given fuzes and fuzed rockets as normally is given in handling mechanical time and impact fuzes. Excessive rough handling may increase fuze malfunctions but will not decrease fuze safety.

f. Transportation.

- (1) If occasion requires the movement of VT fuzed rockets over considerable distances, it is recommended that the fuzes be removed from the rockets. The fuzes should be inserted into their correctly marked individual metal containers and sealed with tape. These fuze containers then should be packed in their original cartons and steel boxes prior to loading on an ammunition carrier.
- (2) Reinsert the supplementary charge (if any) and nose plug in the rockets and replace in properly identified containers.
- (3) If the above is not practicable for short movements of VT fuzed rockets, proceed as with mechanical fuzed rockets.
 - (a) Place several extra cardboard spacers under the fuzed rocket when inserting it in the fiber container. This will take up the play between the shell and the container, thus preventing possible damage to the fuze. This play ordinarily is taken up by the horseshoe support which

engages the wrench slots of the mechanical fuzes. However, the horseshoe support will not enter the wrench slots of the VT fuzes.

- (b) Make sure that the designation on the container indicates the actual fuze which is in the rocket.

g. Disposal of Dud Ammunition.

- (1) *General.* Should it become necessary to recover or dispose of rocket duds, a VT fuze dud may be considered safe for handling, as far as the VT fuze is concerned, 1 hour after the projectile is fired. The impact detonating element in this fuze presents approximately the same problem as a base detonating fuze in that it operates by travel of a detonator carrier, against an anticreep spring, into the fixed firing pin.

- (2) *Condition of impact element in a dud.*

- (a) The impact detonating element (fig. 32) consists of a detonator carrier positioned by two spring-loaded detents and an anticreep spring. On rotation of the rocket, the spring-loaded detents move out of recesses in the detonator carrier, freeing it so that on impact, inertia causes it to strike the fixed firing pin.

- (b) In a dud, the detonator carrier may have moved forward and the anticreep spring, which normally is positioned in a slot in the impact unit body, can no longer restrain the detonator carrier from striking the firing pin. Therefore, in handling a dud, be sure that it is not subjected to a jolt because a jolt may cause the impact element to function and fire the explosive train.

Caution: In the event duds are recovered, they should not be moved and must not be approached closer than 50 feet for 1 hour. When circumstances do not permit destruction of the dud in place, it may be moved with extreme caution by authorized bomb disposal personnel. It must be constantly borne in mind that a dud must not be jolted even to a slight degree because the fuze contains a fully armed impact element which may be functioned by a slight jar or jolt.

h. Demolition of VT Fuzes. See chapter 5.

CHAPTER 3

AIRCRAFT ROCKETS

Section I. 2.0-INCH ROCKETS

56. General

The 2.0-inch fin-stabilized aircraft rocket is a newly designed rocket for forward firing from an aircraft rocket launcher. The rocket is fitted with a high-explosive head and is stabilized in flight by four pivoted fins that are folded within the rocket during packing and shipping. Electrical energy for firing the rocket is derived from the electrical system of the aircraft. A rocket consists of a head, fuze, and motor.

57. Rocket, High-Explosive, 2.0-Inch: Aircraft, M48 (T214E5)

a. This rocket is provided with high-explosive head M2 (T2032E1) and fuze with BDSO rocket fuze M409 (T2033E2). The 2.0-inch rocket motor M13 (T2007E3) consists of the motor tube, composite propellant M22 (T22), and igniter M46 (T36). Refer to chapter 4 for discussion of composite propellants.

b. The rocket is identified by the folding fins. Painting and marking for identification are in accordance with the scheme prescribed in TM 9-1900.

c. As packed, the folded fins are protected by the safety shorting cup, which is fitted over the aft end of the motor. The safety shorting cup must be removed before firing.

58. Rocket, Practice, 2.0-Inch, Aircraft, M49 (T215E5)

This rocket is intended for use as practice ammunition. It is identical to the rocket M48 (par. 57) except that it is provided with inert practice head M3 (T2033E1) and dummy rocket fuze M410 (T2062) instead of head M2 and fuze M409.

Section II. 2.25-INCH ROCKETS

59. General

a. *General Discussion.* The 2.25-inch, fin-stabilized, subcaliber aircraft rocket (fig. 35) is a Navy type used by the United States Air Force for forward-firing from an aircraft rocket launcher.

The rocket is used as practice ammunition in place of the 5.0-inch rocket HVAR which it simulates ballistically. The 2.25-inch rocket is fired from the 5.0-inch rocket launcher Mk 5 adapted for this use by adapter Mk 6. Two lug buttons attached to the motor body of the rocket engage the adapter. Electrical energy to fire the rocket is derived from the electrical system of the aircraft. The rocket consists of an inert head and a motor.

b. Head. The head Mk 3 Mod 2 and other Mods are hollow and threaded externally at the rear to receive the motor.

c. Motor. The motor Mk 11 Mod 0 or 1, Mk 15 Mod 0, or Mk 16 Mod 5 is internally threaded to engage the head. It consists of the motor tube, front closing disk, igniter, propellant, grid, nozzle, nozzle closure electrical cable and igniter plug, suspension buttons and fin assembly. The motor contains the igniter, propellant and grid to position the propellant. Assembled to the motor tube are the nozzle, fin assembly and suspension buttons.

- (1) *Fin assembly.* The fin assembly, which is welded to the rear end of the motor, is a sleeve with four equally spaced rectangular fins extending radially.
- (2) *Propellant.* The propellant is a single grain Mk 16 Mod 0 or 1 of ballistite. See chapter 4 for detailed information.
- (3) *Igniter.* The igniter Mk 112 and Mods is a plastic case containing 14 grams of FFFG black powder and an electric squib. Two lead wires from the squib extend from the igniter passing through the perforation in the propellant grain to the nozzle where they are connected to the electrical cable.
- (4) *Igniter plug.* The igniter plug used with motors Mk 11 Mod 0 or 1 and Mk 15 Mod 0 is a Navy type (two-pronged). The igniter plug used with motor Mk 16 and Mods is an Army type (phone-jack).

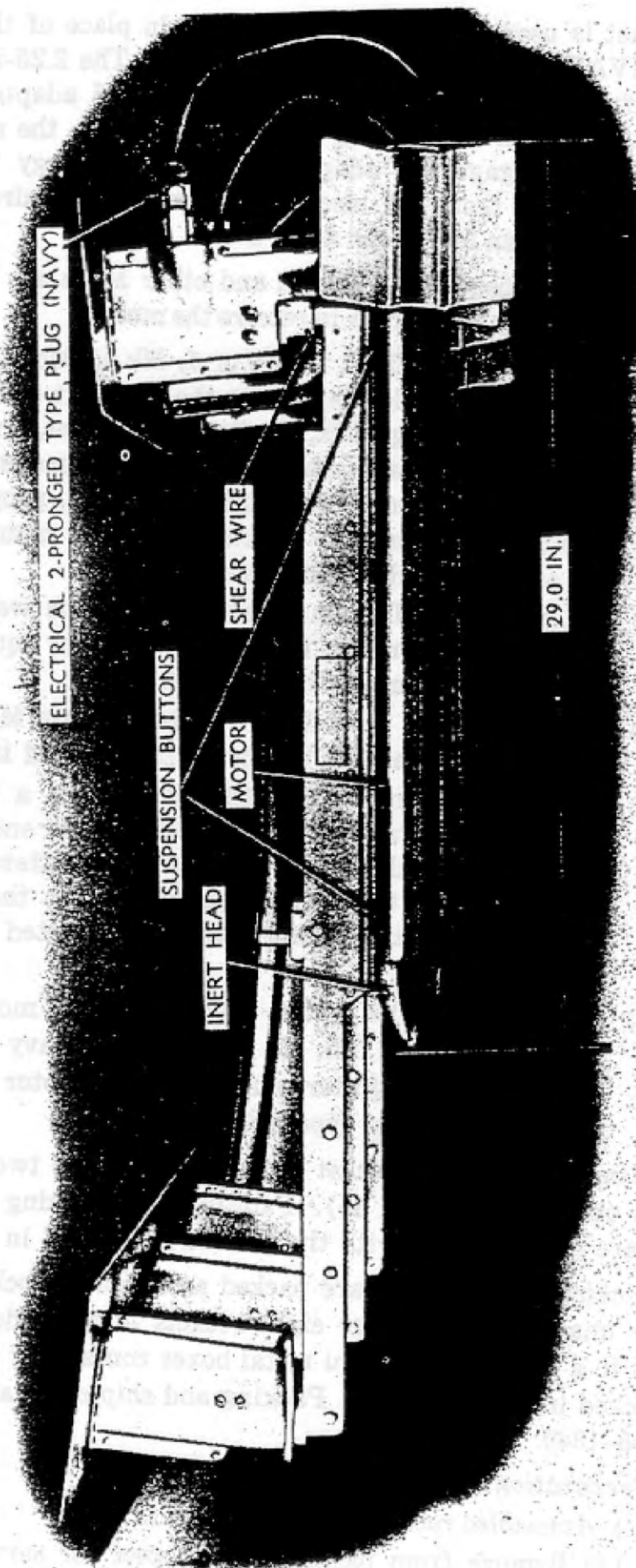
d. Identification. The rocket is identified by the two suspension buttons on the motor (fig. 35). Painting and marking for identification are in accordance with the scheme prescribed in TM 9-1900.

e. Packing. The rockets are packed as complete rockets (assembled or unassembled), either eight rockets to a wooden box, four rockets to a metal box, or two metal boxes containing four rockets overpacked in a wooden box. Packing and shipping data appear in SM 9-5-1340.

f. Preparation for Firing.

- (1) *Assembled rockets.*

- (a) Remove from packing and inspect for serviceability.



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Figure 85. Rocket, practice, 2.25-inch: SCAR (with launcher).

- (b) Should it be considered necessary to test for continuity, test with the circuit continuity tester (par. 14).
- (2) *Unassembled rockets.*
 - (a) Remove head and motor from packing and inspect for serviceability.
 - (b) Remove shipping plugs. Assemble motor and head tightly.
 - (c) Should it be considered necessary to test for continuity, test with the circuit continuity tester (par. 14).
- (3) *Rockets prepared for firing but not fired.* Restore rockets prepared for firing but not fired to original condition and packing. Mark the package of serviceable rockets for prior use in order that opened packages be kept to a minimum.

g. Precautions in Firing. General precautions are given in paragraphs 29 through 37. In addition, the following are applicable to 2.25-inch rockets:

- (1) All firing circuits should be open at the time the rocket is installed in the aircraft. Before plugging in the igniter plug, the electric socket on the launcher should be tested to be certain that the circuit is open.
- (2) The shorting device should not be removed from the igniter plug until the plug is ready to be inserted in the firing circuit of the aircraft.

60. Rocket, Practice, 2.25-Inch: Mk 1 Mod 0 SCAR

The rocket is stored and issued assembled. It consists of the 2.25-inch rocket head Mk 3 Mods 0, 2, 3 and the 2.25-inch rocket motor Mk 11 Mod 0 or 1. This motor has 18.50-inch spacing of suspension buttons. Table III lists the complete round nomenclature, used by the Navy, and data. The rocket has the Navy-type igniter plug as shown in figure 5.

61. Rocket, Practice, 2.25-Inch: Mk 4 Mod 0 SCAR

The rocket is stored and issued assembled or unassembled—motor and head in the same packing container. It consists of the 2.25-inch rocket head Mk 3 Mods 0, 2, 3, and 2.25-inch rocket motor Mk 15 Mods 0 or 2. This motor has 6.0-inch spacing of suspension buttons. Table III lists the complete round nomenclature, used by the Navy, and data. The rocket has the Army-type igniter plug.

62. Rocket, Practice, 2.25-Inch: Mk 6 Mod 0 SCAR

The rocket is similar to that described in paragraph 61. It differs chiefly in having 2.25-inch motor Mk 16 Mods 4, 5, and 6 and 18.50-

inch spacing of suspension buttons. Table III lists the complete round nomenclature, used by the Navy, and data.

Section III. 2.75-INCH ROCKETS

63. General

a. General Discussion. The 2.75-inch fin-stabilized aircraft rocket (fig. 36) is a Navy type used by the United States Air Force for forward-firing from an aircraft rocket launcher. A 2.75-inch HE, AT head has been provided by the Department of the Army for use with the Navy motor. Stabilization in flight is accomplished by four pivoted fins folded within the cross section of the rocket during packing and shipping. The pressure of the propellant gases actuates a piston and crosshead which pushes against the heels of the fins extending them at a 45° angle during flight. The rockets are fired from a launcher consisting of multiple nested tubes arranged in various configurations. Electrical energy to fire the rocket is derived from the electrical system of the aircraft. A rocket consists of a nose fuze, head, and motor.

b. Head. Dependent upon the head, the rockets are high-explosive; high-explosive, antitank (AT); or practice (inert). The head M1, Mk 1 and Mods or Mk 5 Mod 0 is a steel casing internally threaded at the nose to receive the fuze and externally threaded at the base to engage the motor. A threaded cup-shaped cavity liner is screwed in the nose.

c. Motor. The motors Mk 1 and Mods, Mk 2 and Mods, or Mk 3 and Mods are internally threaded to receive the head. They consist essentially of an aluminum alloy motor tube containing propellant and an igniter and having a nozzle-fin assembly attached to the aft end.

(1) *Propellant.* The propellant is one inhibited grain of ballistite. Refer to chapter 4 for detailed description.

(2) *Igniter.* The igniter is a tin case containing a mixture of black powder and magnesium powder and an electric squib and is located in the forward end of the motor. Two lead wires from the squib extend from the igniter passing through the perforation in the propellant grain to the nozzle-fin assembly where one lead wire is grounded to the nozzle plate. The other lead wire passes through a nozzle and is connected to the contact disk at the aft end of the rocket as the live contact.

(3) *Nozzle-fin assembly.* The nozzle-fin assembly consists essentially of a nozzle plate, four nozzle inserts, a fin-actuating mechanism, four fins, a fin retainer and a contact

the rocket is rectangular and divided into two sections. The top section is the motor and the bottom section is the warhead. The motor is made of a composite material and the warhead is made of a high explosive material. The rocket is designed to be fired from a ground launcher and to travel a distance of 1000 feet. The rocket is shown in a side view and is labeled with the following information:

2.75 IN.
COMP B
ROCKET
MI
PA-22-55

RA PD 257422

48.7 IN MAX

Figure 36. Rocket, high-explosive, 2.75-inch: FFAR, AT, M1.

the rocket is rectangular and divided into two sections. The top section is the motor and the bottom section is the warhead. The motor is made of a composite material and the warhead is made of a high explosive material. The rocket is designed to be fired from a ground launcher and to travel a distance of 1000 feet. The rocket is shown in a side view and is labeled with the following information:

disk. The aluminum alloy fins are rectangular and pivoted on the nozzle plate. As packed and shipped, the fins are within the 2.75-inch diameter of the rocket. When the rocket is fired, the propellant gas pressure acting on the fin-actuating mechanism causes the fins to extend from the motor at a 45° angle. The contact disk, which is insulated from the rocket, serves as live contact during firing.

d. Fuze. Fuzes used with the 2.75-inch rocket heads Mk 1 and Mods are point detonating (PD) type Mk 176 with a delay element and Mk 178 instantaneous. Heads Mk 5 use (PD) type Mk 181 fuzes and the point initiating (PI) type M406. Practice and inert rocket heads are fuzed with inert fuzes. See paragraphs 75 through 84 for fuze description.

e. Identification. The rocket is identified by the folded fins and contact disk at the aft end. Painting and marking for identification are in accordance with the scheme prescribed in TM 9-1900.

f. Packing. As packed, the folded fins are protected and the rocket shorted by a fin protector fitting over the aft end of the motor. The rockets are packed as complete rockets (assembled or unassembled) or with fuzed heads and motors separate. Packing and shipping data appear in SM 9-5-1340.

- (1) *Complete rockets.* Complete rockets (assembled or unassembled) are packed four to a metal container Mk 1 Mod 0.
- (2) *Heads.* Rocket heads are packed either one in a metal can, four cans to a wooden box or four to a complete round metal container Mk 1 Mod 0.
- (3) *Motors.* Rocket motors are packed either four in a complete round metal container Mk 1 Mod 0 or one per metal can Mk 13, four cans per metal box Mk 15.

g. Preparation for Firing.

- (1) *Assembled rockets.*
 - (a) Remove from packing and inspect for serviceability.
 - (b) Should it be considered necessary to test for continuity, test with the circuit continuity tester (par. 14).
 - (c) Remove the fin protector before loading the rocket in the launcher.
- (2) *Unassembled rockets.*
 - (a) Remove head and motor from packing and inspect for serviceability.
 - (b) Remove shipping plugs. Assemble motor and fuzed head tightly.
 - (c) Should it be considered necessary to test for continuity, test with the circuit continuity tester (par. 14).

(d) Remove the fin protector before loading the rocket in the launcher.

(3) *Rockets prepared for firing but not fired.* Restore all rockets prepared for firing but not fired to original condition and packing. Mark the package of serviceable rockets for prior use in order that opened packages be kept to a minimum.

h. Precautions in Firing. General precautions are given in paragraphs 3 through 17. In addition, the following are applicable to 2.75-inch rockets:

(1) Do not remove the fuze cavity liner.

(2) Rockets which have a gap between the head and motor should not be used.

(3) All firing circuits should be open at the time the rocket is installed in the aircraft.

(4) The fin protector should not be removed until immediately before loading in the launcher.

64. Rocket, High-Explosive, 2.75-Inch: FFAR (Motor Mk 1 Mod 3 or 4)

The rocket is intended for air-to-air use. The delay element in the fuze permits the rocket to enter an aircraft structure before detonating. The rocket consists of the HBX-1 loaded head Mk 1 and Mods fuze with PD fuze Mk 176 and the motor Mk 1 Mod 3 or 4. The rocket is packed and shipped with fuze head and motor unassembled in the same packing or in separate packing. Table III lists the complete round nomenclature, used by the Navy, and data.

65. Rocket, High-Explosive, 2.75-Inch: FFAR (Motor Mk 2 and Mods)

The rocket is similar to that in paragraph 66 except for the motor Mk 2 and Mods.

66. Rocket, High-Explosive, 2.75-Inch: FFAR, AT, M1

The rocket (fig. 36) is provided for air-to-ground use against tanks and other armored vehicles. It consists of the Army 2.75-inch head M1 fuze with PI fuze M406 and the Navy motor. Contained in the head is a copper cone, apex to the rear, which acts to shape the high-explosive charge of 0.89 pounds of composition B. The penetration effect is derived from the shaped charge. See table III for data.

67. Rocket, High-Explosive, 2.75-Inch: FFAR, AT

The rocket is intended for use against armored targets. It con-

sists of the head Mk 5 Mod 0 fuze with PD fuze Mk 181. The penetration effect is derived from the shaped charge of composition B. The rocket is shipped and packed as an unassembled rocket, head and motor either together or in separate packing containers. Table III lists the Navy complete round nomenclature and data.

68. Rocket, Practice, 2.75-Inch: FFAR (Motor Mk 1 Mod 3)

The rocket is intended for use as practice ammunition. The rocket consists of the inert loaded head Mk 1 and Mods with inert fuze and the motor Mk 1 Mod 3. The rocket is shipped and packed as an unassembled rocket, head and motor either together or in separate packing containers. Table III lists the Navy complete round nomenclature and data.

69. Rocket, Practice, 2.75-Inch: FFAR (Motor Mk 2 and Mods)

This rocket is similar to that described in paragraph 68 except for the motor Mk 2 and Mods.

70. Rocket, Practice, 2.75-Inch: FFAR (Motor Mk 3 and Mods)

This rocket is similar to that described in paragraph 69 except for motor Mk 3 and Mods.

Section IV. 5.0-INCH ROCKETS

71. General

a. General Discussion. The 5.0-inch, fin-stabilized, aircraft rocket (fig. 37) is a Navy type used by the United States Air Force for forward-firing from aircraft. The 5.0-inch rocket is fired from Air Force retractable jettisoning launcher using suspension bands. Electrical energy to fire the rocket is derived from the electrical system of the aircraft. A rocket consists of a fuze head and a motor.

b. Complete Round. The Department of the Army stores 5.0-inch base fuze rocket heads, nose fuzes, VT fuzes, and rocket motors separately. The base fuze heads, nose or VT fuzes, and motors are assembled to make up various complete rounds whose Navy nomenclature and data is given in table III.

c. Preparation for Firing.

(1) The 5.0-inch rocket is prepared for firing as follows:

- (a) Remove head fuze and motor from packings and inspect for serviceability.
- (b) Remove shipping plugs. Assemble motor and head tightly.
- (c) Install nose or VT fuze, if required.

b. *Fuze.* The 5.0-inch HVAR head Mk 6 Mods is permanently fuze with base fuze Mk 159 Mod 1 or Mk 164 and Mods. The heads Mk 6 and Mods and Mk 25 Mod 1 receive nose fuze Mk 149 Mod 0 or 1 after removal of the nose shipping cap. Head Mk 6 Mod 4 receives VT fuze M403 or M403E2 (Mk 172 Mod 2).

c. *Identification.* Painting and marking for identification are in accordance with the scheme prescribed in TM 9-1900.

d. *Packing.* The 5.0-inch HVAR head Mk 6 and Mods is packed two per wooden box or 48 per pallet (except Mk 6 Mod 4). The head Mk 25 Mod is packed one per wooden box with two lug bands, with or without arming wire. Nose and VT fuzes are packed 20 per wooden box. VT fuzes are packed one per metal can, nine cans per wooden box. Packing and shipping data appear in SM 9-5-1340.

73. 5.0-Inch Rocket Motors

Listed below are various similar 5.0-inch rocket motors which are assembled with 5.0-inch HVAR heads to form complete rockets as indicated in tables II and III. The motor Mk 10 differs from the motor Mk 2 principally in having an Army igniter plug instead of a Navy (bayonet-type) plug. The 5.0-inch motor is externally threaded at the forward end to engage the head. It consists of the motor tube, front closure disk, igniter, propellant, nozzle plate, suspension lugs and fin assembly. The motor contains the igniter, propellant and grid to position the propellant. Assembled to the motor tube are the nozzle, fin assembly and suspension lugs.

MOTOR, 5.0-INCH ROCKET: Mk 2 Mod 3.

MOTOR, 5.0-INCH ROCKET: Mk 2 Mod 3 (w/bayonet-type connector plug).

MOTOR, 5.0-INCH ROCKET: Mk 10 Mods 4 and 5.

MOTOR, 5.0-INCH ROCKET: Mk 10 Mods 4 and 5 (w/electrical connector Mk 11 Mod 5 or M3).

MOTOR, 5.0-INCH ROCKET: Mk 10 Mod 7 (w/o fin).

MOTOR, 5.0-INCH ROCKET, EMPTY: Mk 2 Mod 3.

MOTOR, 5.0-INCH ROCKET, INERT: Mk 2 Mod 3.

a. *Fin Assembly.* The fin assembly, which is clamped to the rear end of the motor, is a sleeve with four equally spaced rectangular fins extending radially.

b. *Propellant.* The propellant is a single grain Mk 18 Mod 0 of ballistite. Refer to chapter 4.

c. *Igniter.* The igniter is a metal can containing 55 grains of black powder and an electric squib. Two lead wires from the squib extend from the igniter passing through the perforation in the pro-

pellent grain to the nozzle where they are connected to the electrical cable and igniter plug (connector).

d. *Identification.* The motor is identified by the two suspension lugs (fig. 37). Painting and marking for identification are in accordance with the scheme for Navy rockets prescribed in TM 9-1900.

e. *Packing.* Inert or propellant loaded motors are packed (with or without fins) one per wooden box. Empty motors are packed three per wooden box. Packing and shipping data appear in SM 9-5-1340.

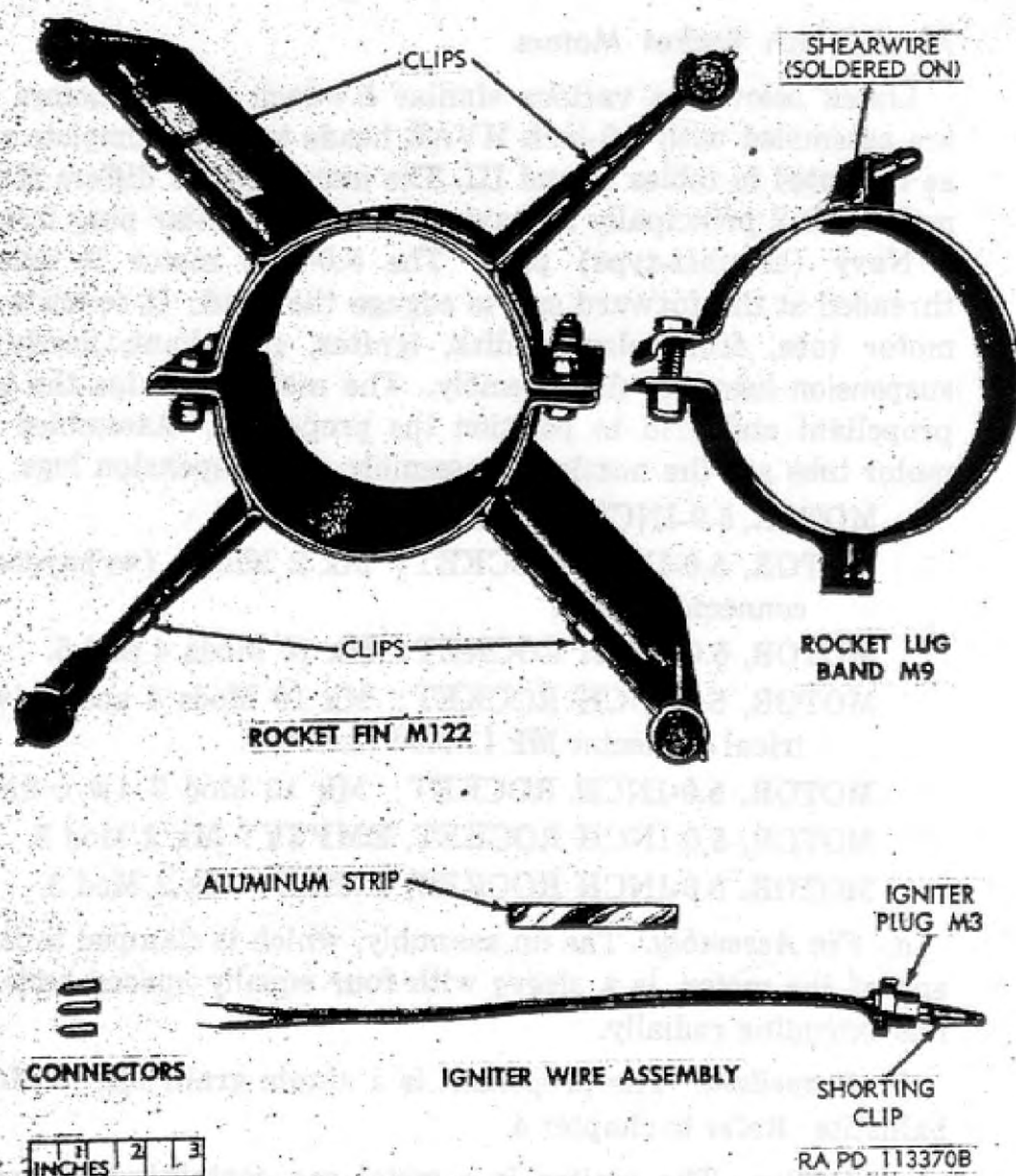


Figure 38. Fin assembly kit, 5.0-inch rocket: M34 (T38) for 5.0-inch high-velocity aircraft rocket (Navy).

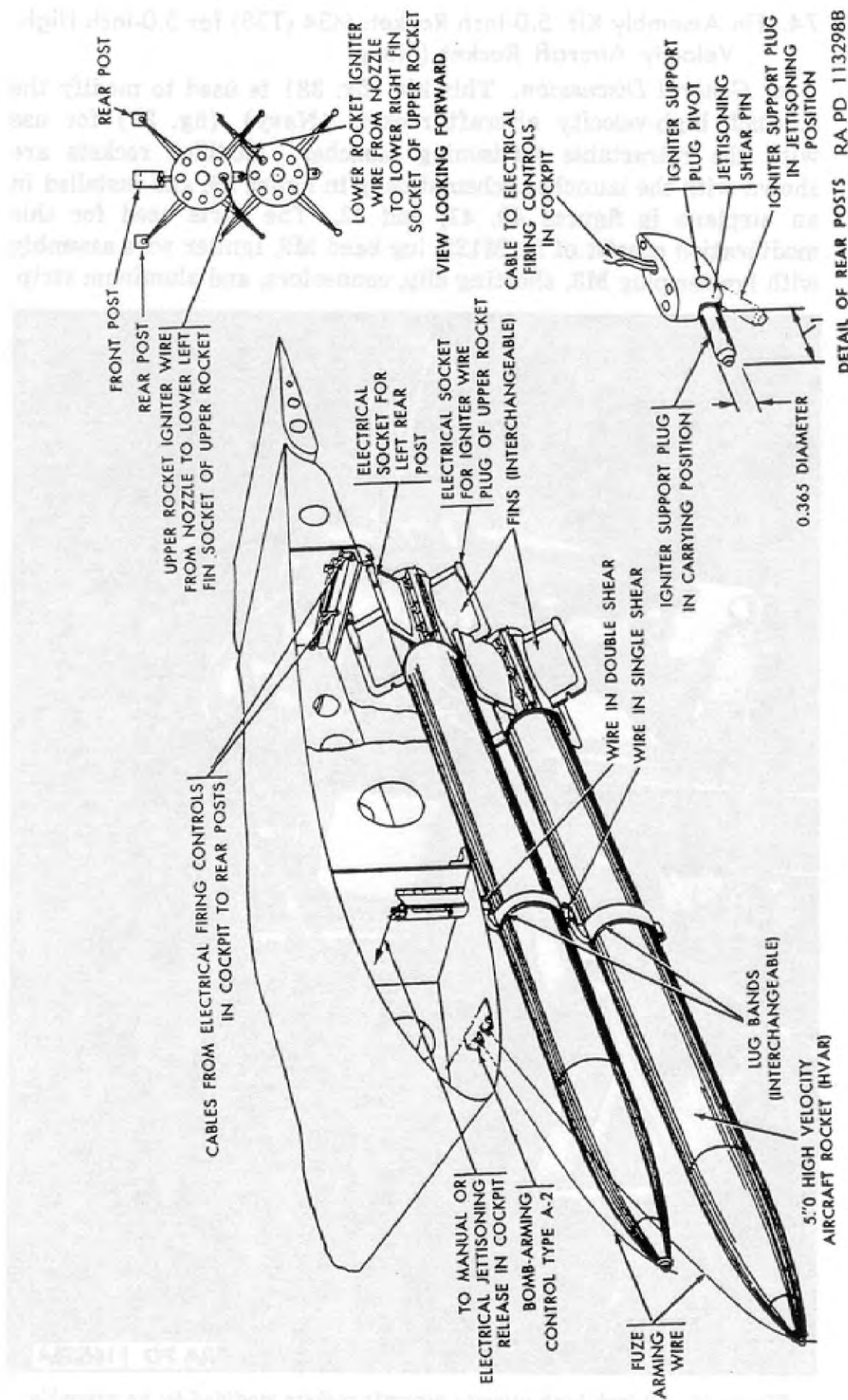


Figure 39. Schematic arrangement of 5.0-inch high-velocity aircraft rocket, as modified by rocket kit M34, installed in retractable jettisoning aircraft launcher.

74. Fin Assembly Kit, 5.0-Inch Rocket: M34 (T38) for 5.0-Inch High-Velocity Aircraft Rocket (Navy)

a. *General Discussion.* This kit (fig. 38) is used to modify the 5.0-inch high-velocity aircraft rockets (Navy) (fig. 37) for use with the retractable jettisoning launcher. Modified rockets are shown with the launcher schematically in figure 39, and installed in an airplane in figures 40, 41, and 42. The parts used for this modification consist of fin M122, lug band M9, igniter wire assembly with igniter plug M3, shorting clip, connectors, and aluminum strip.

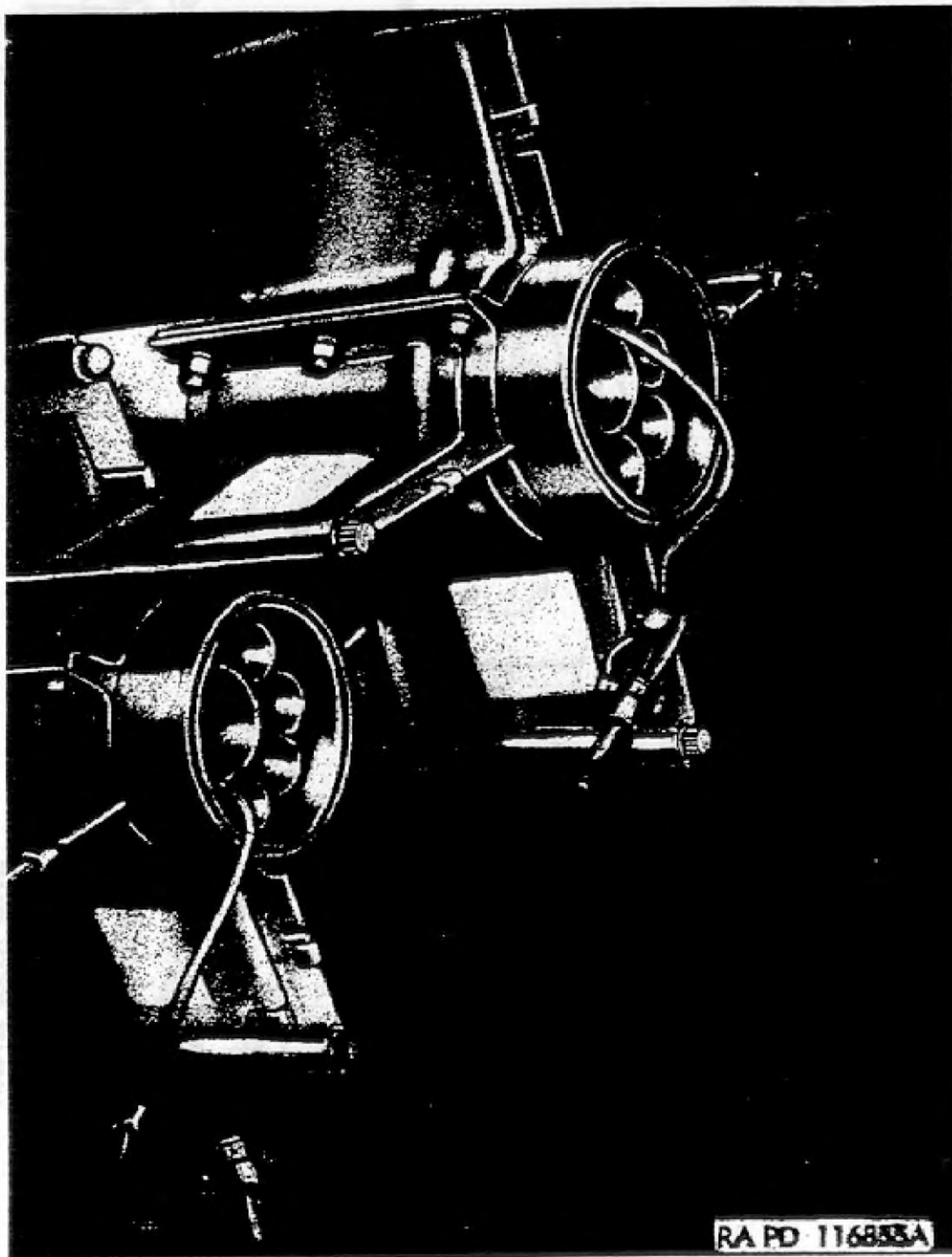


Figure 40. 5.0-inch high-velocity aircraft rockets modified by fin assembly kit M34, as assembled to rear launcher posts.

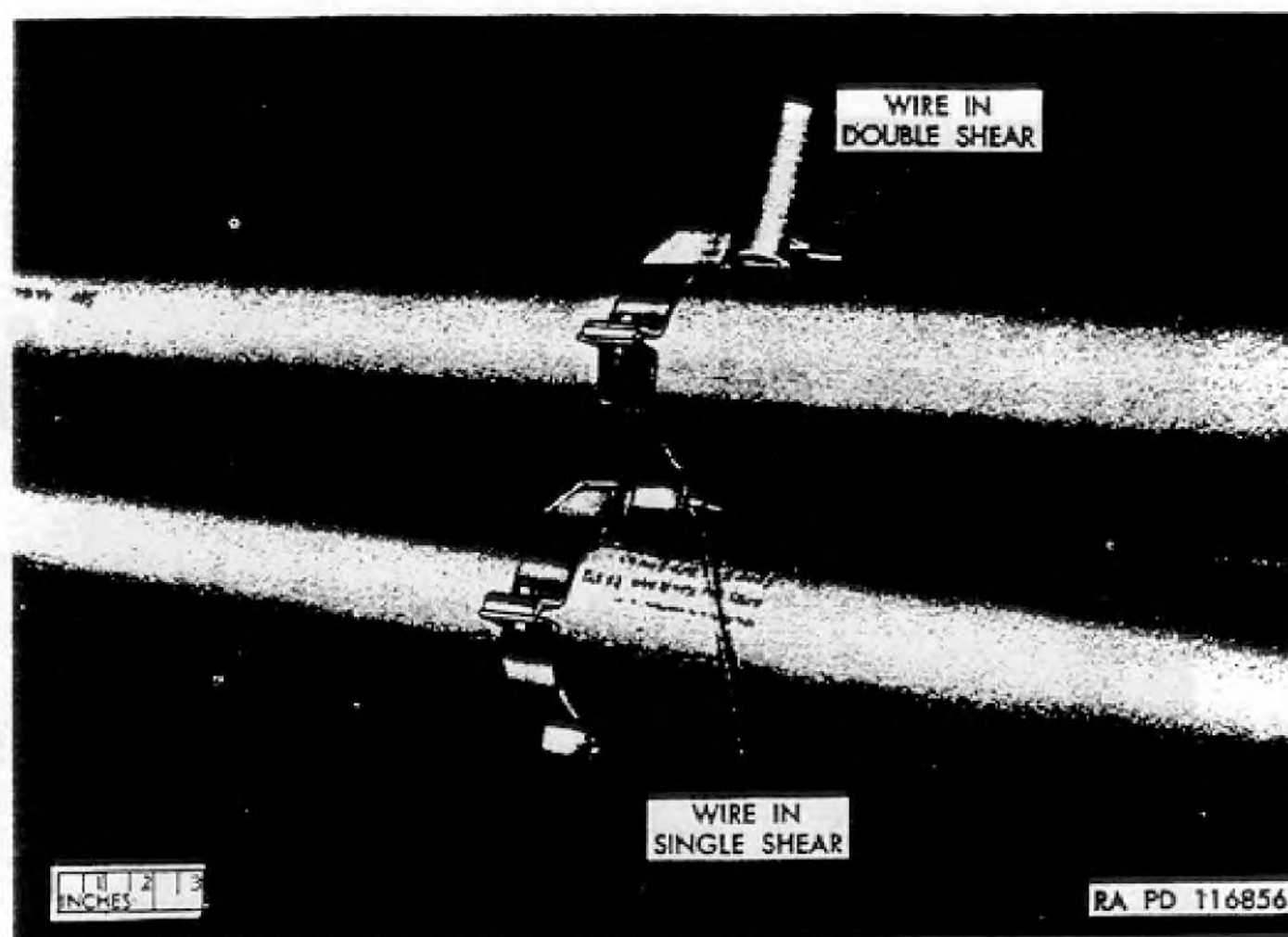


Figure 41. 5.0-inch high-velocity aircraft rockets modified by fin assembly kit M34, with front lug band assembled to front launcher post.

- (1) The fin, fabricated from sheet aluminum, has four blades. It is made in two halves with flanges and bolts which provide for clamping the fin securely to the rocket. At the rear outer corner of each blade is an electrical socket with protector cap. When the fin flanges are horizontal, the two upper sockets, after removal of the protector caps, are for engagement with the rear launcher posts which support the rear end of the rocket (figs. 39 and 40). With reference to the "view looking forward" of figure 39, the lower left socket of the upper rocket is for insertion of the plug of the igniter wire leading from the upper rocket; the lower right socket of the upper rocket is for insertion of the plug of the igniter wire from the lower rocket. The sockets at the rear of the outer edge of the blades of the fin of the lower rocket play no part in the firing; hence, the protector caps are left on. At approximately the middle of the leading and rear edges of each blade is a slot. The slots in the rear edges of the uppermost blades of the fin of the lower rocket engage the slots in the leading edges of the lower blades of the fin of the upper rocket. Diametrically opposite sockets are connected by a single insulated wire which passes within the blades and through a bead in the body of the fin. Each wire has a solderless

Characteristically opposite sockets are connected by a single insulated wire which passes within the plates and through a hole in the body of the fin. Each wire has a solderless

terminal which is a small metal plate soldered to the end of the wire. The terminal is connected to the opposite socket of the fin.

With the

terminal

socket

which

terminal

socket

which

terminal

socket

which

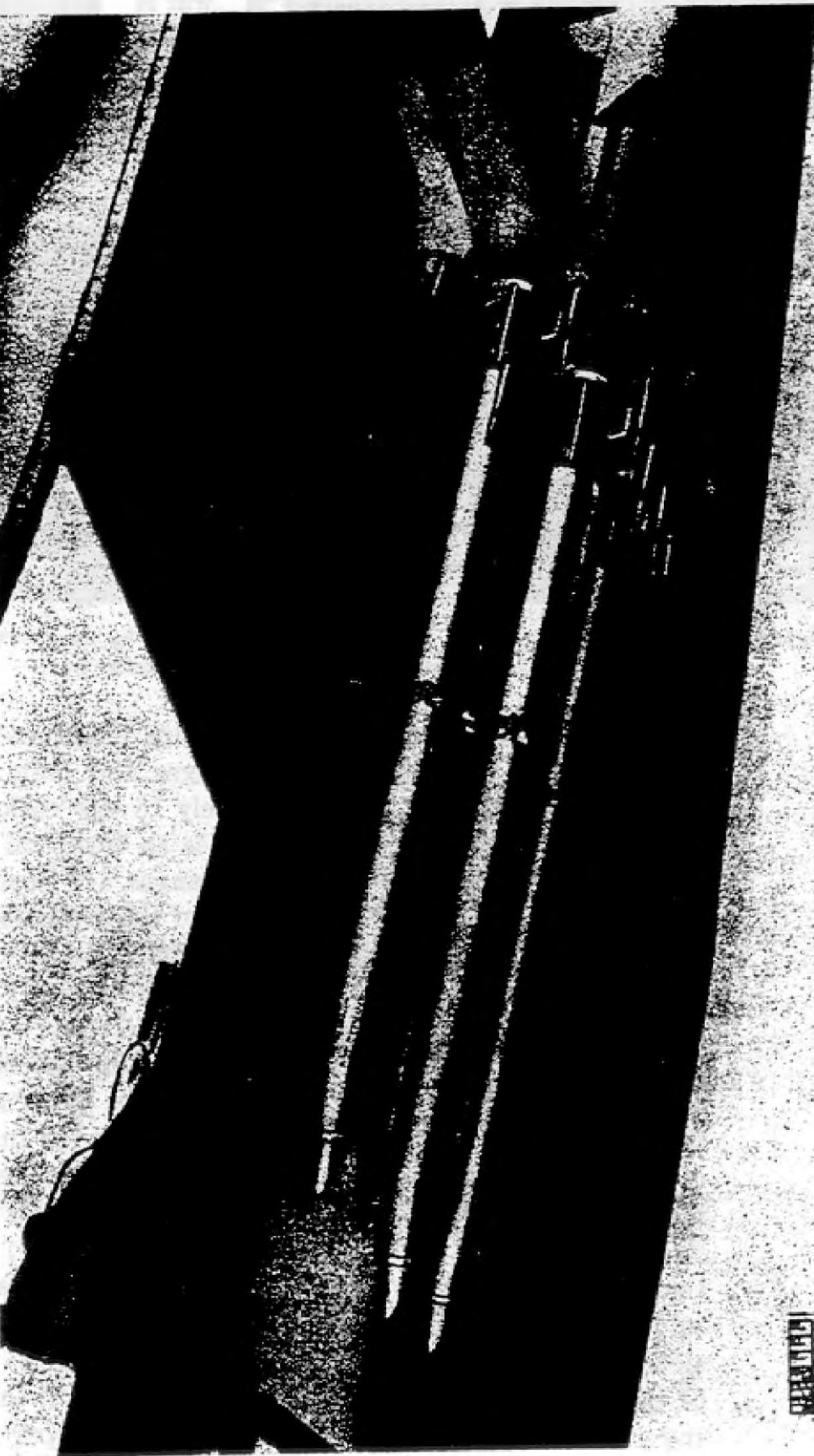
terminal

socket

which

terminal

socket



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00000000

Figure 42. 5.0-inch high-velocity aircraft rockets modified by fin assembly kit M34, installed on airplane.

connector splice at the flange. Small metal clips are attached to the rear edges of all blades for taking up the slack in rocket igniter wires (fig. 38). When rockets are installed on the launcher and the igniter plugs are plugged into the appropriate sockets, the igniter wires as indicated in figure 43 are inserted under the clips on the rear edge of fins and the clips closed with pliers or fingers. The surplus igniter wire is gathered close to the nozzle of the rocket and bind the folds, as shown, with the aluminum strip furnished with the rocket kit.

- (2) The lug band, which is designed to be clamped to the rocket forward of the fin, has a lug and, diametrically opposite, a socket. The lug fits into a mating hole in the front launcher post for suspension of the front of the rocket. The socket of the lug band receives the lug on the lug band of a second rocket which may be suspended from the rocket installed directly on the launcher. Thus, two rockets may be installed on one launcher—the upper one directly on the launcher, the lower one suspended from the upper. To secure the rocket on the launcher, a shear wire is inserted through a hole in the protruding end of the lug. This shear

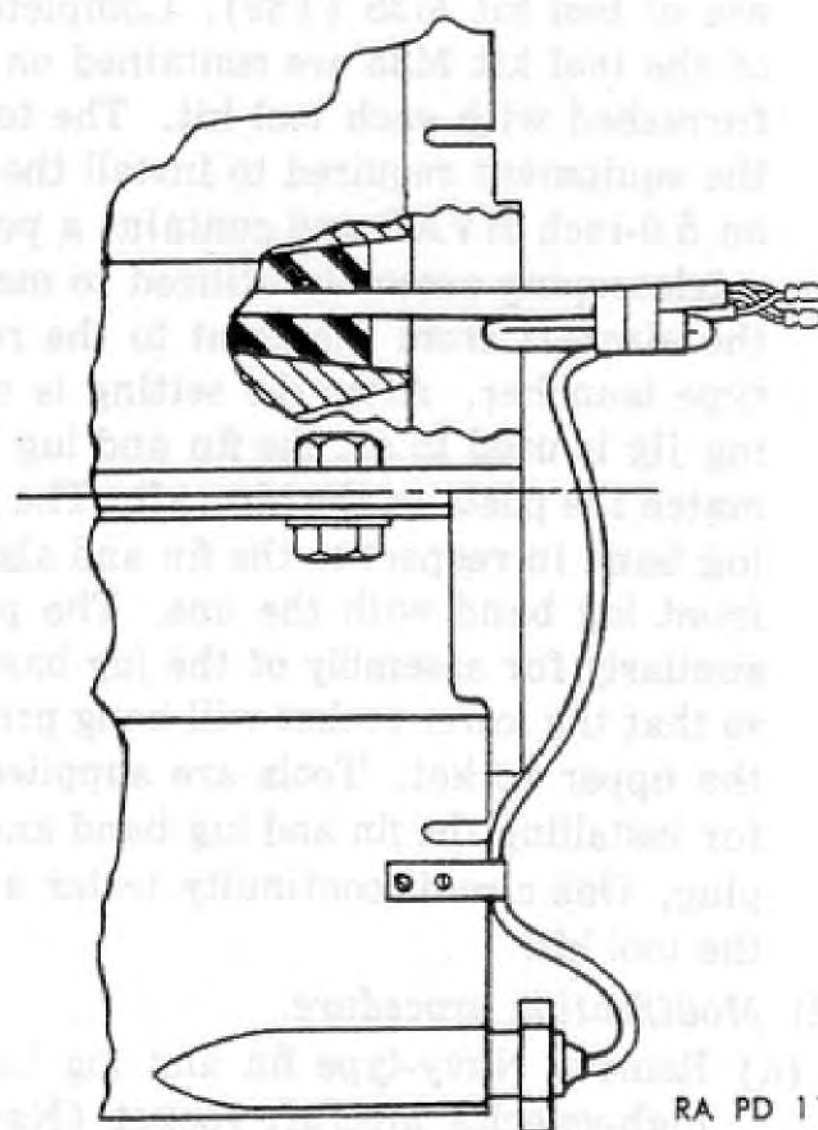


Figure 43. Igniter wire assembly with plug inserted in rocket fin and slack taken up.

wire is furnished with the lug band, the bent end being lightly soldered or welded to the lug to prevent its loss. It should be noted that the rear face of the front launcher post, adjacent to the hole in the post, is flat; whereas, that of the socket on the lug band is relieved on one side. Hence, the shear wire in the lug of rocket which is installed directly in the launcher (upper rocket) will be in "double shear," while the shear wire in the lug of the lower rocket will be in "single shear" (fig. 41). Thus, the lower rocket may be fired without carrying the upper rocket with it, since the force required to shear a wire in single shear is half of that required to shear the upper wire, which is in double shear.

- (3) The igniter wire assembly consists of an Army-type plug which consists of a head, a tapered shank with insulated tip, and lead wires. The tapered shank is for ground contact and the insulated tip is for live contact.

b. Modification of 5.0-Inch High-Velocity Aircraft Rocket (Navy).

- (1) *General.* The modification of a 5.0-inch high-velocity aircraft rocket (Navy type) with rocket kit M34 involves the use of tool kit M35 (T39). Complete instructions for use of the tool kit M35 are contained on the instruction sheet furnished with each tool kit. The tool kit M35 comprises the equipment required to install the modification kit M34 on 5.0-inch HVAR and contains a positioning jig which is a telescoping assembly utilized to measure the distance on the aircraft from the front to the rear posts of the flush type launcher. After the setting is obtained, the positioning jig is used to set the fin and lug band on the rocket to match the posts on the aircraft. The jig positions the front lug band in respect to the fin and also aligns the fin of the front lug band with the fins. The positioning jig is used similarly for assembly of the lug band on the lower rocket so that the lower rocket will hang properly suspended from the upper rocket. Tools are supplied in the tool kit M35 for installing the fin and lug band and to attach the igniter plug. One circuit continuity tester assembly is included in the tool kit.

(2) *Modification procedure.*

- (a) Remove Navy-type fin and lug band from the 5.0-inch high-velocity aircraft rocket (Navy) to be modified.
- (b) Loosen the bolts of fin M122 (fig. 38).
- (c) Slip the fin (M122) over the rear end of the rocket and

assemble so that the rear face of the fin assembly bears on the front face of the shroud ring which surrounds the nozzle end of the rocket motor. The shroud ring provides longitudinal support for the fin during firing, and prevents the type of malfunction that would result if the fin should slip off. Tighten the six nuts on the fin to an approximate torque of 25-pound-foot which will bend the flanges and cause them to contact each other. Use ratchet handles and 1/2-inch sockets.

Note. If practicable, 3 of the bolts may be removed before slipping the fin assembly over the shroud ring at rear of rocket, and then the bolts reassembled.

- (d) Assemble the lug band loosely on the rocket at approximately its correct position.
- (e) Set positioning jig (figs. 44 and 45) to the launcher post spacing as follows:
 1. Examine finger holder "D" to see if it strikes any obstruction on the airplane. If finger holder "D" strikes

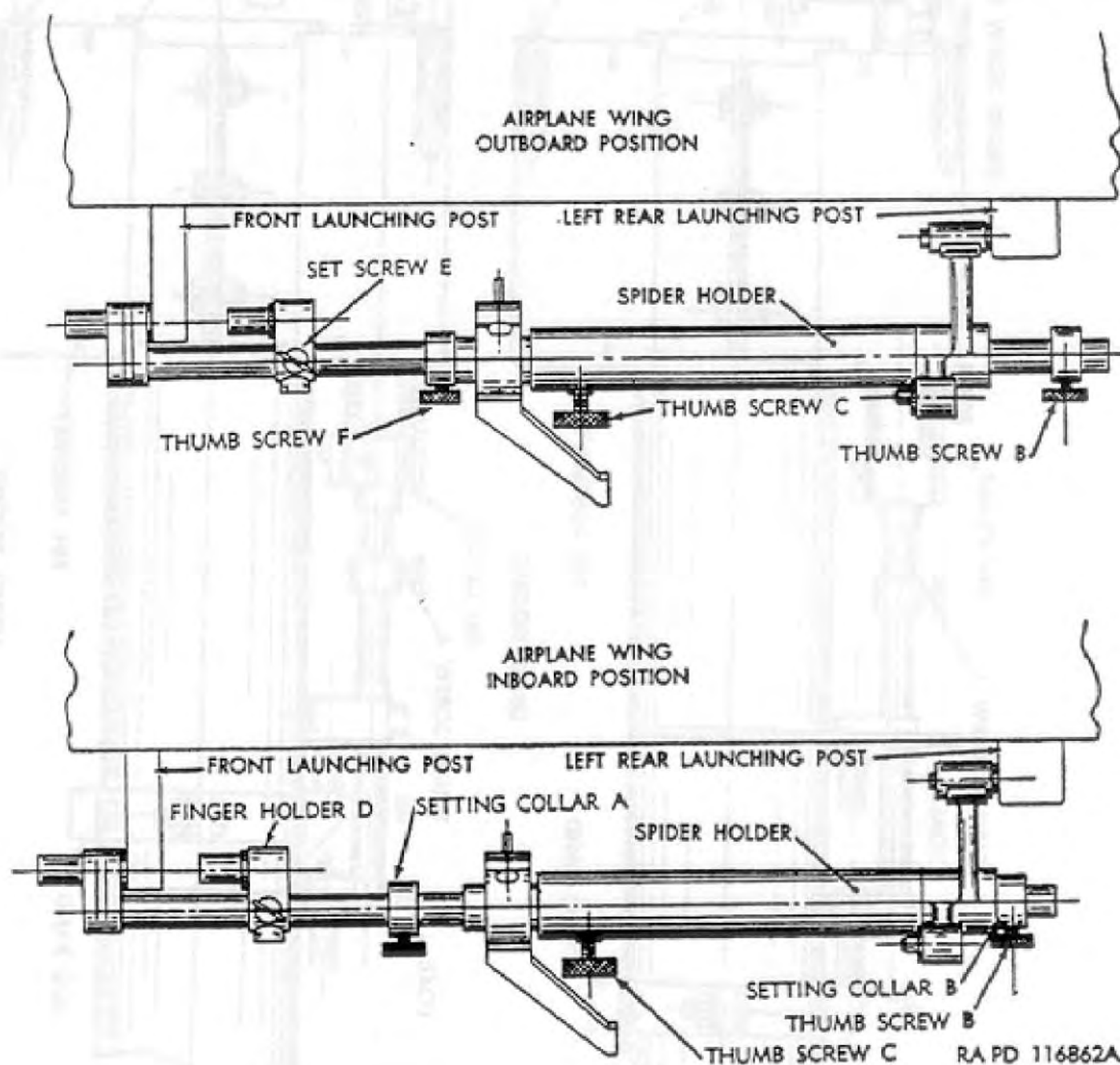


Figure 44. Tool kit M35 (T39), for use with rocket kit M84—positioning jig in outboard and inboard positions.

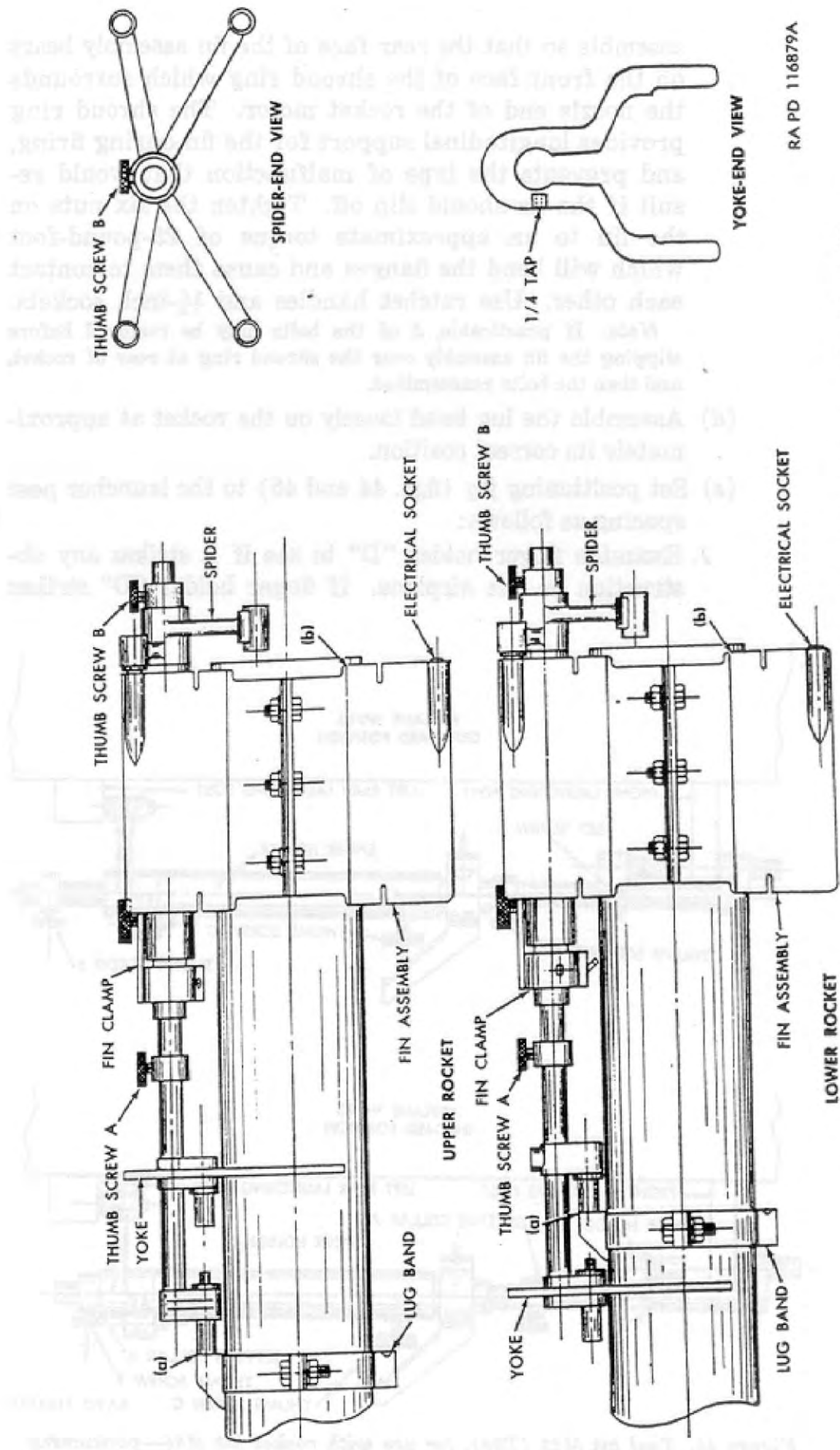


Figure 45. Tool kit M35 (T39)—positioning jig—locating lug band on rockets for inboard position.

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an obstruction remove setscrew "E" and rotate finger holder "D" 90° to the rear. Reinsert setscrew "E" through tapped hole "F." (The setting finger should be reset to its original position after jig is set to launcher post spacings.)

2. To set the jig for the outboard launcher, loosen thumb screw "C" and place the jig in the outboard launcher posts as if installing a rocket. Make sure that the bushings of the jig bear on the shoulders of the rear launcher posts and front face of the front launcher post; also, that collars "A" and "B" do not bear on the spider holder during this setting operation.
3. Tighten thumb screw "C."
4. Slide collar "A" to touch the end of the spider holder; then tighten thumb screw "A."
5. Check this setting of the jig by observing proper contact at the front and rear launcher posts.
6. To set the jig for the inboard position, loosen thumb screw "C" and place jig in the inboard launcher. This operation is similar to that described above for the outboard launcher except that, in this case, collar "B" should be slid to touch the end of the spider holder and thumb screw "B" then should be tightened.
7. Thus the jig is set for the outboard launcher when the spider holder is moved to the left to contact the collar "A" and the thumb screw "C" tightened, or for the inboard launcher when the spider holder is moved to the right to contact collar "B" and thumb screw "C" tightened.
8. It should be noted, in comparing figures 44 and 45, that for the parts of the jig which mate with the launchers there are corresponding but opposite parts which correspond to launcher connections each displayed a fixed distance to the left; also, that after setting the jig for the particular launcher, the spider holder is rotated 180° before placing the jig on the rocket to locate the lug band properly. It should be noted further that the counterpart of the lug that fits into the front launcher post is displaced to the right a distance equal to the length of the fin. Thus the lug band of the lower rocket may be located from the original setting of the jig.

Note. If necessary the above settings may be changed to the average spacings of all launchers in a squadron.

(f) Assembly yoke to positioning jig (fig. 45) as shown in

view for upper rocket or lower rocket as applicable. Secure with thumb screw that fits into threaded hole indicated by "1/4-TAP" in figure 45.

(g) Remove rocket caps from rocket fin, and assemble the positioning jig to the rocket as shown in view for upper or lower rocket as applicable. Move fin clamp to the right to bear against the leading edges of the two uppermost blades of fin as shown and secure by tightening the fin clamp thumb screw, which is on the fin clamp.

(h) Be sure that the face of the lug ((a), fig. 45) bears on the face of the positioning jig bushing as shown in views of both upper and lower rocket positions. Tighten the lug band bolt to 33 pound-foot torque to hold the lug band securely to the rocket.

(i) Loosen the fin clamp and remove the positioning jig. The alinement of the lug band must be such that the positioning jig can be freely removed from the socket with the yoke in place as shown. Replace the sockets caps.

(j) Remove the shipping cover from the nozzle of the 5.0-inch Navy rocket (HVAR) being modified. Cut the rocket igniter wire 3 inches from the nozzle plate (A, fig. 46) with the hand tool furnished with tool kit M35 (T39). Using the No. 10 shinner position on the hand tool, remove 1 inch of the outer rubber covering of the rocket igniter wire. Do not cut the insulation of the leads. Using the No. 20/No. 22 shinner position of the hand tool, remove insulation from 1/4 inch of the end of each igniter lead (B, fig. 46). Be careful not to cut wires in this operation.

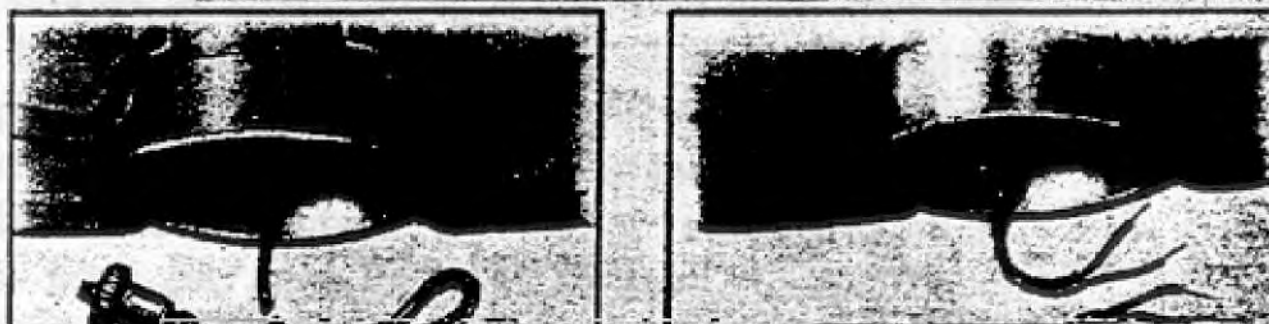
(k) Connect one of these igniter leads (C, fig. 46) to one lead of an igniter plug assembly (furnished with the rocket kit M34) as follows: Open the crimping tool (furnished with tool kit M35 (T39)) and insert closed-end connector (furnished with rocket kit M34) until it bottoms on the stop. Close the crimping tool slightly so that it just holds the connector. Insert the two wires to be connected, making sure that each wire bottoms in the connector. Close the crimping tool the remainder of the way, completing the crimping operation.

Note. The crimping tool is equipped with an automatic ratchet so that the tool must be closed completely before it can be reopened.

(l) Connect the other two wires in the same manner.

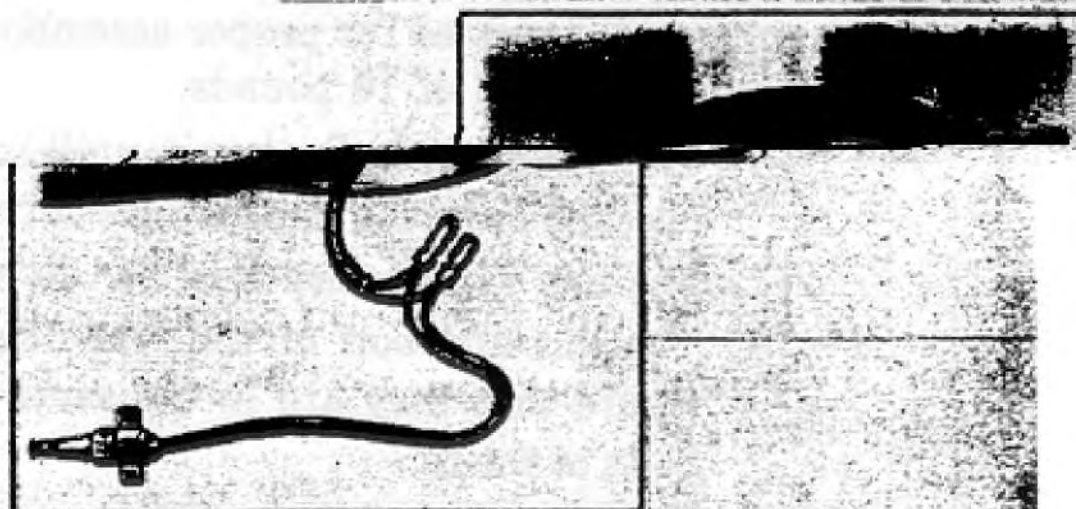
(m) Test each connection by applying a pull of approximately 10 pounds.

A—NAVY "ELECTRICAL CONNECTOR" WITH NAVY TWO-PRONGED PLUG ATTACHED TO 5.0-INCH HIGH VELOCITY AIRCRAFT ROCKET, AND ARMY "IGNITER PLUG ASSEMBLY"



BE DISCARDED

B—END OF NAVY "ELECTRICAL CONNECTOR" AND ENDS OF ITS LEADS, AND ENDS OF ARMY "IGNITER WIRE" LEADS—PREPARED FOR INSERTION INTO SOLDERLESS CONNECTORS



C—ENDS OF LEADS CONNECTED BY SOLDERLESS CONNECTORS AND FOLDED TOGETHER

RA PD 116865

Figure 46. Replacement of Navy electrical connector and 2-prong plug by Army igniter wire and plug.

Note. One spare connector is furnished with each rocket kit M34. Additional spare connectors and igniter plug assemblies are furnished with tool kit M35 (T39).

- (n) Remove the shorting clip from the plug and check the rocket's electrical circuit using circuit continuity tester (par. 14).
 - (o) After testing the circuit, be sure that the shorting clip is replaced on the igniter plug. Coil the igniter plug assembly and place it inside the nozzle ring of the rocket. Replace the shipping cover.
 - (p) Ordinarily, rockets will be modified in quantities just sufficient to meet immediate requirements. In any event, rockets modified in accordance with the above instructions should be clearly marked to show the nature of the modification. Such marking should include: type of airplane for which modified; particular launcher for which modified, such as inboard or outboard as applicable; location of rocket on launcher, such as UPPER if for installation directly on launcher, LOWER if for suspension from the underside of upper rocket in launcher; date and designation of unit or agency accomplishing the modification. Rockets modified and not used immediately should be repacked and the package marked to show clearly the contents, including all essential information as to the modification.
- (3) *Inspection procedure.* Immediately after installation of the M34 modification kit on the 5.0-inch HVAR, the following inspections will be made:
- (a) The igniter plug splice will be tested for proper assembly by exerting an approximate pull of 10 pounds.
 - (b) The electrical continuity of rocket squib circuits will be checked by using the circuit continuity tester (par. 14).
 - (c) The fins will be inspected for distortion or alinement.
 - (d) The nut and bolt of the front lug will be examined to insure that they are in the same plane as the nuts and bolts of the fin.
 - (e) The electrical sockets will be examined to insure that the spring loaded electrical contacts are in operating condition by inserting a screwdriver or other implement and pushing the electrical contact back.
 - (f) Care will be taken in replacing the shipping cap over the nozzle to insure that the electric wire is not damaged.
- (4) *Intermediate connector.* The intermediate connector (fig.

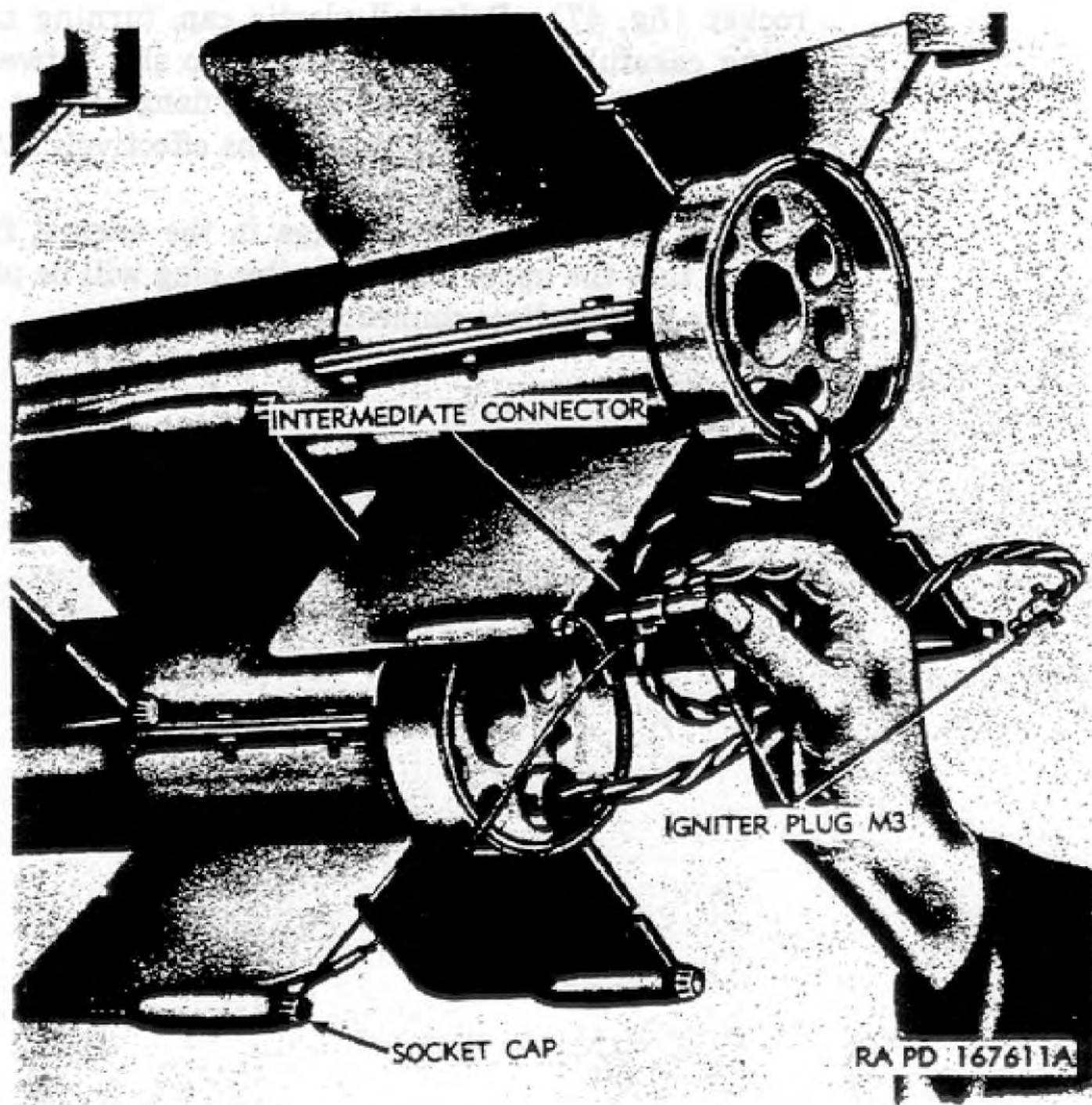


Figure 47. 5.0-inch high-velocity aircraft rockets modified by fin assembly kit M34, with intermediate connector.

47) is a safety device required for all double hung rockets. Its function is to short circuit the upper rocket until the lower rocket is fired, thus preventing the upper rocket from being fired until after the lower rocket has been fired.

- (a) Install intermediate connector into the left hand lower socket of the upper rocket fin in the same manner as an igniter plug (fig. 47). The red line on the connector is lined up with upper "J" slot on the rocket fin socket, and then rotated clockwise so that the red line becomes alined with the fin.
- (b) Remove plastic cap on the left hand lower socket of the lower rocket.
- (c) Place the wire loop of the connector into the notch on the fin adjacent to the left hand lower socket of the lower

rocket (fig. 47). Reinstall plastic cap, turning tightly, being careful not to let the wire loop slip between the overhanging lip of the notch and the flange on the socket cap. The wire loop is by this means effectively attached to the lower rocket (fig. 47).

- (d) Plug in the rocket igniter plugs in the normal fashion except that the upper rocket igniter plug will be plugged into the intermediate connector.

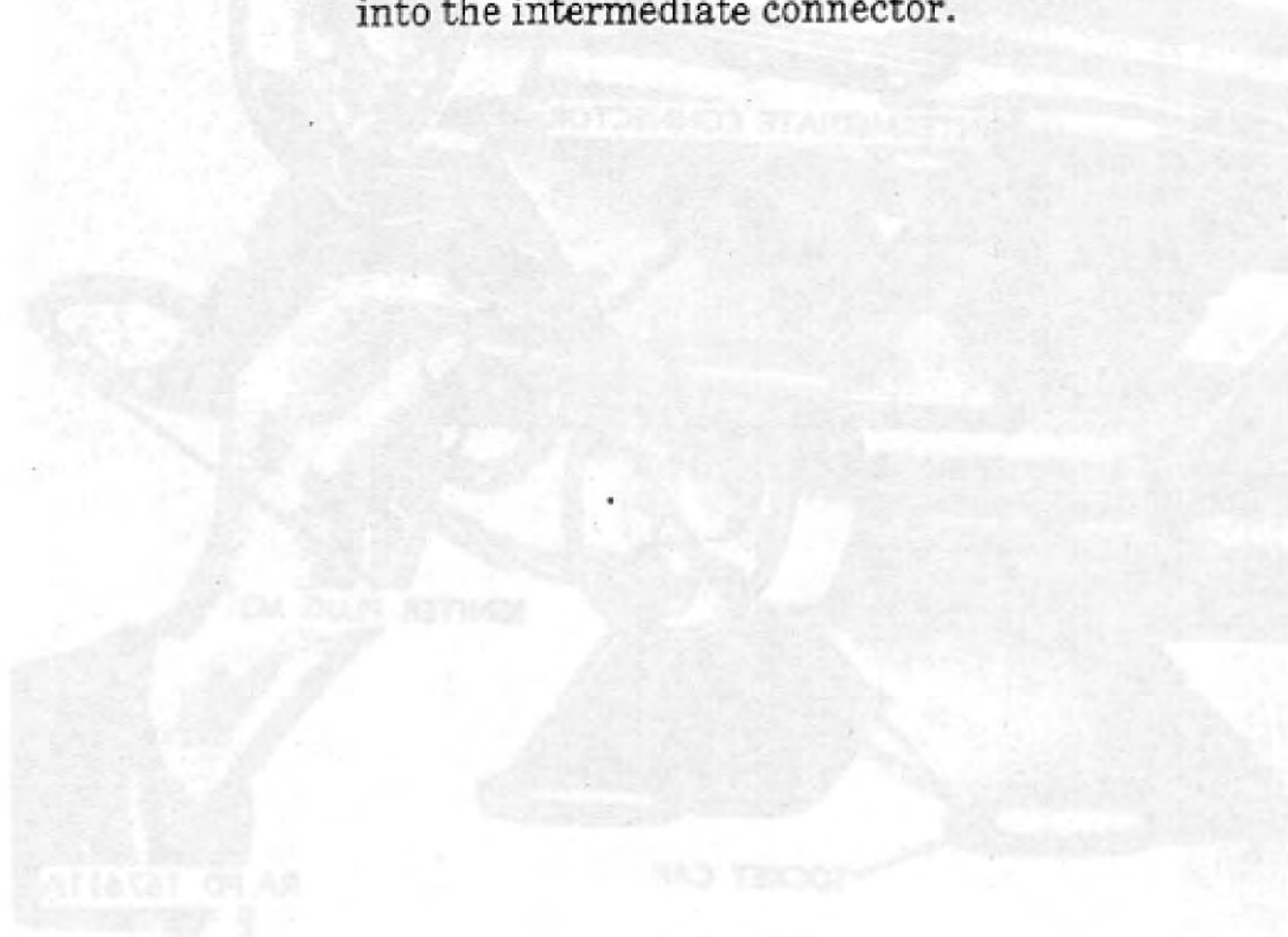


Figure 47 - Rocket assembly showing modified RA PD 123456 and intermediate connector.

477 is a safety device required for all double hung rockets. The function is to short circuit the upper rocket until the lower rocket is fired, thus preventing the upper rocket from being fired until after the lower rocket has been fired.

(c) Install intermediate connector into the left hand lower socket of the upper rocket in the same manner as an igniter plug (fig. 47). The red line on the connector is lined up with upper "1" slot on the rocket in socket, and then rotated clockwise so that the red line becomes aligned with the fit.

(d) Remove plastic cap on the left hand lower socket of the lower rocket.

(e) Place the wire loop of the connector into the notch on the fit adjacent to the left hand lower socket of the lower

Table II. Components Comprising Complete Rounds of Aircraft Type Rockets and Related Data

Head			Motor			Fuze		Velocity (fps)	Use
Diameter (in.)	Mark and Mods	Filler	Diameter (in.)	Mark and Mods	Propellant grain	Nose	Base		
2.0	M2	-----	2.0	M13	M22	None	M409	-----	Service
2.0	M3	Steel	2.0	M13	M22	None	M410	-----	Practice
2.25	Mk 3 Mod 2 Mod 3	Zinc Mal. Iron	2.25	Mod 0 Mk 11 Mod 1	Mod 0 Mk 16 Mod 1	None	None	1,130	Target practice (subcali- ber for 5.0-inch rocket)
2.25	Mod 0 Mk 3 Mod 2 Mod 3	Steel Zinc Mal. Iron	2.25	Mk 15 Mod 0 Mod 2	Mk 16 Mod 1	None	None	1,130	Target practice (subcali- ber for 5.0-inch rocket)
2.25	Mod 0 Mk 3 Mod 2 Mod 3	Steel Zinc Mal. Iron	2.25	Mod 4 Mk 16 Mod 5 Mod 6	Mk 16 Mod 1	None	None	1,130	
2.75	Mk 1	COMP B	2.75	Mk 1 or Mk 2	Mk 31	PI M406	None	2,300	Service
2.75	Mk 1 Mods	HBX-1	2.75	Mk 1 Mod 3 or 4	Mk 31	Mk 176 Mk 178	None	2,300	Service
2.75	Mk 1 Mods	HBX-1	2.75	Mk 2 Mods	Mk 43 Mods	Mk 176 Mk 178	None	2,300	Service
2.75	Mk 1 Mods	HBX-1	2.75	Mk 3 Mods	Mk 43 Mods	Mk 176 Mk 178	None	2,300	Service
2.75	Mk 5 Mod 0	COMP B	2.75	Mk 2 Mods	Mk 43 Mods	Mk 181	None	2,300	Service (armor piercing)

Table II. Components Comprising Complete Rounds of Aircraft Type Rockets and Related Data—Continued

Diameter (in.)	Head		Motor		Propellant grain	Fuze		Velocity (fps)	Use
	Mark and Mods	Filler	Diameter (in.)	Mark and Mods		Nose	Base		
2.75	Mk 1 (inert)	Inert	2.75	Mk 2 Mod 5 Mk 1 Mod 3 or 4 Mk 3 Mods	Mk 31	Inert	None	2,300	Practice
2.75	Mk 1 (inert)	Inert	2.75	Inert		Inert	None		Drill
5.0	Mk 6 Mods	TNT	5.0	Mk 10 Mods	Mk 18 Mod 0	Mk 149 Mod 0 or 1	Mk 164 Mod 0	1,325	Service
5.0	Mk 6 Mod 4	TNT	5.0	Mk 10 Mods	Mk 18 Mod 0	Mk 149 Mod 0	Mk 164 Mod 0	1,325	Service
5.0	Mk 6 Mods	Plaster	5.0	Mk 10 Mods	Mk 18 Mod 0	None	None	1,325	Practice
5.0	Mk 6 Mods	Plaster	5.0	Mk 2 Mod 3	None	None	None	None	Drill
5.0	Mk 25 Mod 1	COMP B	5.0	Mk 10 Mods	Mk 18 Mod 0	Mk 149 Mod 0	None	1,325	Service (armor piercing)

Table III. Physical and Ballistic Data for Aircraft Type Rockets

Size of rocket		2.25-inch	
Army Complete Round Nomenclature.		ROCKET, PRACTICE 2.25-INCH: SCAR.	ROCKET, PRACTICE 2.25-INCH: SCAR.
Navy Complete Round Nomenclature.		2.25-inch Rocket Mk 4 Mod 0 (aircraft practice).	2.25-inch Rocket Mk 6 Mod 0.
HEAD—Mark and Mod	Length (in.)	Mk 3 Mods	Mk 3 Mods
	Diameter (in.)	3.75	3.75
Type of filler	Weight (lb)	2.25	2.25
	Type of filler	1.60	1.60
Motor—Mark and Mod		solid	solid
Length (in.)	Diameter (in.)	Mk 11 Mod 0 or 1	Mk 15 Mod 0 or 2
	Weight (lb)	26.20	26.20
Model of propellant	Weight of propellant (lb)	2.25	2.25
	Weight of propellant (lb)	10.40	10.40
FUZE—type, Mark and Mod		Mk 16 Mod 1	Mk 16 Mod 1
ROCKET (assembled)		1.75	1.75
Length (in.)		None	None
Weight (lb)		29.20	29.20
Velocity (max) (fps)		12.00	12.00
Temperature limits (° F.)		11.30	11.30
Burning time (static) (sec)		20 to 110	20 to 110
Burning time (effective) (sec)		0.79 to 0.37	0.79 to 0.37
Burn-out point (ft from launcher)		0.64 to 0.10	0.64 to 0.10
		440 to 230	440 to 230

Table III. Physical and Ballistic Data for Aircraft Type Rockets—Continued

Size of rocket	2.75-inch					
Army Complete Round No-menclature.	ROCKET, HIGH-EX- PLOSIVE, 2.75-INCH: FFAR, AT M1.	ROCKET, HIGH-EX- PLOSIVE, 2.75-INCH: FFAR.	ROCKET, HIGH-EX- PLOSIVE, 2.75-INCH: FFAR, AT.	ROCKET, PRACTICE, 2.75-INCH: FFAR.	ROCKET, PRACTICE, 2.75-INCH: FFAR.	ROCKET, INERT, 2.75-INCH: FFAR.
Navy Complete Round No-menclature.	-----	Mk 2 Mod 0	Mk 4 Mod 0	Mk 5 Mod 0		
HEAD—Mark and Mod	M1	Mk 1 Mods	Mk 1 Mods	Mk 5 Mod 0	Mk 1 (inert)	Mk 1 (inert)
Length (in.)	11.1					
Diameter (in.)	2.75					
Weight (lb)	6.47					
Type of filler.	COMP B	HBX-1	HBX-1	COMP B	Inert loaded	Inert loaded
MOTOR—Mark and Mod	Mk 1 or Mk 2	Mk 1 Mod 3 or 4	Mk 2 Mods	Mk 2 Mods	Mk 1 Mod 3 or 4	Mk 2 Mods
Length (in.)	32	32	32	32	32	32
Diameter (in.)	2.75	2.75	2.75	2.75	2.75	2.75
Weight (lb)	12.13	12.13	12.13	12.13	12.13	12.13
Model of propellant	M31 or M43	Mk 31	Mk 43 Mods	Mk 43 Mods	Mk 31	Mk 43 Mods
Weight of propellant (lb)	-----	6.6	6.4	6.4	6.6	6.4
FUZE—type, Mark and Mod.	Nose PI M406	PD Mk 176	PD Mk 176	PD Mk 181	PD Mk 176	PD Mk 176
						Inert

ROCKET (assembled)		48		48		48		48		48	
Length (in.)	48.7	18.1		18.1		18.1		18.1		18.1	
Weight (lb)	18.65	2,300		2,300		2,300		2,300		2,300	
Velocity (max) (fps)	-----	-----		-----		-----		-----		-----	
Temperature limits (° F.).	—65 to 150	—65 to 150		—65 to 150		—65 to 150		—65 to 150		—65 to 150	
Burning time (static) (sec).	-----	1.69		1.69		1.69		1.69		1.69	
Size of rocket		5.0-inch (HVAR)									
Army Complete Round Nomenclature.	ROCKET, HIGH-EXPLOSIVE, 5.0-INCH: HVAR	ROCKET, HIGH-EXPLOSIVE, 5.0-INCH: HVAR		ROCKET, HIGH-EXPLOSIVE, 5.0-INCH: HVAR, AT		ROCKET, PRACTICE, 5.0-INCH: HVAR		ROCKET, DUMMY, 5.0-INCH: HVAR			
Navy Complete Round Nomenclature.	5.0-inch Rocket, Mk 4 Mod 0 (aircraft general purpose).	5.0-inch Rocket, Mk 28 Mod 4 (aircraft general purpose).		5.0-inch Rocket, Mk 32 Mod 1 (aircraft, heat).		5.0-inch Rocket, Mk 5 Mod 0 (aircraft practice).		5.0-inch Rocket, Mk 6 Mod 0 (aircraft dummy).			
HEAD—Mark and Mod	Mk 6 Mod 4	Mk 6 Mods		Mk 25 Mod 1		Mk 6 Mods		Mk 6 Mods			
Length (in.)	16.73	16.73		-----		16.73		16.73			
Diameter (in.)	5.0	5.0		-----		5.0		5.0			
Weight (lb)	45.5	45.5		-----		45.5		45.5			
Weight of filler (lb)	7.5 TNT	7.50 TNT		7.50 COMP B		7.50 plaster		7.50 plaster			
MOTOR—Mark and Mod	Mk 10 Mod 6	Mk 10 Mod 6		Mk 10 Mods		Mk 10 Mod 6		Mk 10 Mod 6			
Length (in.)	-----	52.0		52.0		52.0		52.0			
Diameter (in.)	5.0	5.0		5.0		5.0		5.0			
Weight (lb)	-----	89.3		89.3		89.3		89.3			

Table III. Physical and Ballistic Data for Aircraft Type Rockets—Continued

Size of rocket		5.0-inch (HVAR)			
Model of propellant Weight of propellant (lb)	Mk 18 Mod 0	Mk 18 Mod 0	Mk 18 Mod 0	Mk 18 Mod 0	Mk 18 Mod 0
	23.9	23.9	23.9	23.9	23.9
FUZE—type, Mark and Mod	Nose	Nose	Nose	Nose	Nose
	VT Fuze M403 or M403E2	Mk 149 Mod 0 or 1	Mk 149 Mod 0	Mk 149 Mod 0	None
ROCKET (assembled)	Base	Base	Base	Base	Base
	Mk 164 Mods	Mk 164 Mod 0	Mk 164 Mod 0	Mk 164 Mod 0	None
Length (in.)	68.6	68.6	68.6	68.6	68.6
Weight (lb)	1360	1340	1340	1340	1340
Velocity (max) (fps)	—20 to 120	—20 to 120	—20 to 120	—20 to 120	—20 to 120
Temperature limits (°F.)	—20 to 120	—20 to 120	—20 to 120	—20 to 120	—20 to 120
Burning time (static) (sec)	—20 to 120	—20 to 120	—20 to 120	—20 to 120	—20 to 120
Burning time (effective) (sec).	—20 to 120	—20 to 120	—20 to 120	—20 to 120	—20 to 120

Section V. TIME AND IMPACT FUZES FOR AIRCRAFT TYPE ROCKETS

75. General

See paragraph 9 for general information on fuzes.

76. Fuze, Rocket: Base, Mk 159 and Mod 1

a. The Mk 159 fuze is for use in the high-velocity fin-stabilized rocket with 5-inch head and 5-inch motor. The fuze Mk 159 Mod 1 (fig. 48) has a flange head diameter of 3.2 inches, a length of 5.813 inches, and a projectile-type gas check.

b. Just prior to assembly of a round on aircraft, a nose fuze Mk 149 usually is installed in the head. The Mk 149 can be set "instantaneous" or "safe." Thus, the round is provided at the time of firing with instantaneous or 0.015-second delay action. The fuze Mk 149 Mod 1 usually is used with rockets which are fired against light fortifications, tanks, locomotives, and similar targets.

c. The explosive components are—

- (1) Delay detonator—housed in shutter.
- (2) Lead-in—housed in lead-in disk.
- (3) Booster — approximately 12 grams (0.42 oz) tetryl — housed in magazine.

d. The fuze head screws into the base of the rocket head. The projectile-type gas check and a rubber gasket make a gastight seal

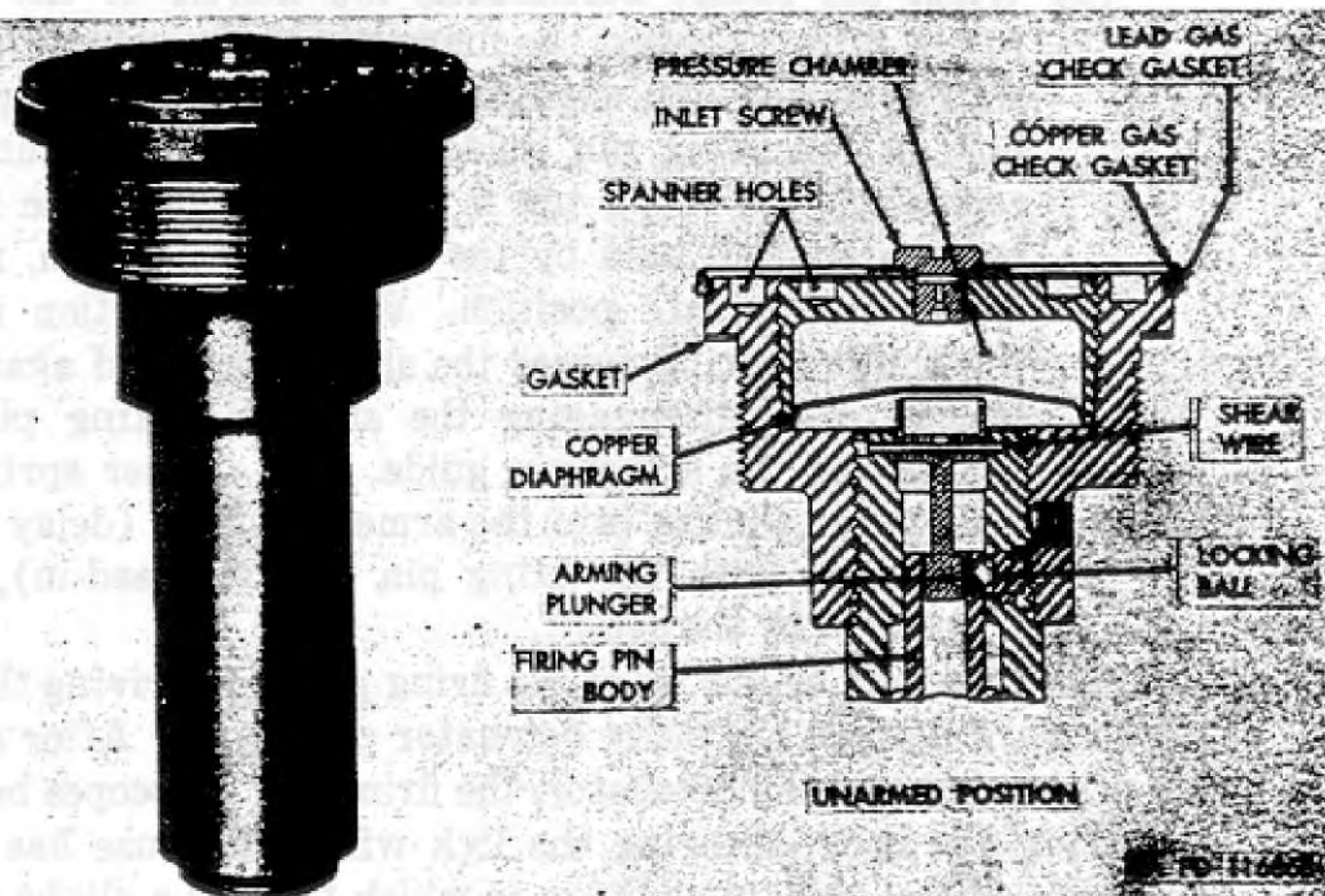


Figure 48. Fuze, rocket: base, Mk 159 Mod 1.

in the body between the rocket motor and the interior of the rocket head. The rear end of the fuze (the exterior surface of the plug) is exposed to the front end of the rocket motor. The fuze body extends into the cavity in the fuze seat liner in the interior of the rocket head.

e. This fuze is armed by gas pressure from the motor at the time of firing. The head of the fuze contains a gas pressure chamber located between the diaphragm and the closing plug. The fuze arms in two stages as follows:

- (1) Through a small orifice in the inlet screw, gases from the rocket motor slowly enter the pressure chamber in the head of the fuze. Debris from the rocket motor is filtered out by the inlet washer. When the pressure in the chamber has reached between 325 and 375 psi, which is delayed by the small orifice in the inlet screw until half the burning time is consumed, the diaphragm collapses, forcing the arming plunger down and shearing the shear wire which holds the plunger in place. Movement of the plunger releases the locking ball, which, in the unarmed condition, locks the firing pin body in place, and allows the latter to move toward the rear under the force of the firing pin spring and the inertia of the firing pin body due to acceleration. The firing pin, attached to the firing pin body by a lock wire, thus is withdrawn from the delay-detonator shutter which it normally locks in the safe position.

- (2) When the rocket accelerates, the inertia of the shutter forces it back against the firing pin guide, compressing the shutter spring and engaging the shutter locking pin in a hole in the firing pin guide. About midway during acceleration, the firing pin is withdrawn from the shutter, but the shutter, held by the shutter locking pin, remains locked in the safe position. When acceleration is over, the shutter spring forces the shutter forward against the lead-in disk, disengaging the shutter locking pin from the hole in the firing pin guide. The shutter spring then swings the shutter into the armed position (delay detonator in line with the firing pin and the lead-in), where it is locked by the detent.

f. The fuze fires by inertia of the firing pin body driving the firing pin forward against the delay detonator on impact. After striking the primer in the delay detonator, the firing pin telescopes back into the firing pin body, shearing the lock wire. The fuze has a fixed delay of 0.015 second, in addition to which there is a slight delay in firing, inherent in the forward motion of the firing pin body and firing pin on impact. The delay detonator initiates the tetryl lead-in

and tetryl booster. This action directly detonates the auxiliary booster beneath the fuze and the main filler of the rocket.

g. The safety features of the fuze are—

- (1) This fuze is detonator safe. In the unarmed position, the detonator is out of alinement with the explosive train. Should the detonator function prematurely, the force of the detonator will be dissipated upward through a hole in the firing pin guide and away from the explosive components.
- (2) Due to the delay in admission of gas from the rocket motor to the pressure chamber, the first stage in arming does not occur instantaneously after ignition of the motor. Total arming is not accomplished until acceleration has ceased. The burning distance, and therefore the arming distance, will vary with the temperature.
- (3) The lightweight aluminum arming plunger and the shear wire make the fuze in a full weight projectile safe from arming by accidental dropping from heights up to at least 40 feet.

h. The fuze is shipped installed in the base of the 5-inch rocket head. No safety wire is needed and no preparations are required to ready the fuze for use. In this respect, this fuze is comparable to a projectile base fuze. The shipping cover over the base of the head protects the exposed end of the fuze. This cover should be kept in place until the round is to be assembled, and should be replaced promptly if the round is disassembled. Before assembling the rocket motor onto the rocket head, check that the fuze is tight in place in the base of the head, and that the fuze inlet screen has not become dirty so as to clog the orifice.

i. In disposal of the head, in case of a motor failure or firing which does not result in a detonation, extreme care should be exercised. The fuze should be removed from an unexploded head only by qualified bomb disposal personnel. There is no way to determine by examination whether or not the fuze is armed. If it is armed the fuze will fire if the head is dropped on its nose or jarred so as to permit the firing pin to strike the primer in the delay detonator.

j. The following servicing precautions should be observed:

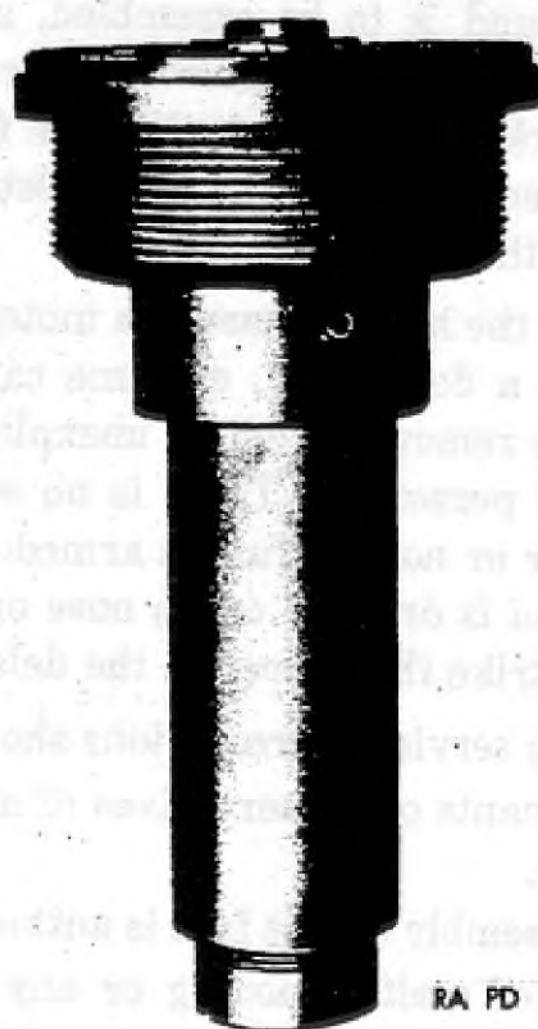
- (1) No lubricants or preservatives of any kind may be used on this fuze.
- (2) No disassembly of this fuze is authorized.
- (3) Reports of malfunctioning or any difficulties encountered with this fuze should be reported to the chief of the technical service concerned. The report should contain the lot

number and the other markings of the fuze, as well as the complete detailed history of its failure to function (par. 2).

k. Fuzes will be shipped assembled with the rocket heads and protected by a shipping cover which is secured to the adapter ring by machine screws. The fuze is stamped with mark (Mk), modification (Mod), lot number, the date of loading, and the loaders name or initials.

77. Fuze, Rocket: Base, Mk 164 and Mods

This fuze (fig. 49) is essentially the same as the Mk 159 Mod 1 (par. 76) except certain internal modifications. This fuze (fig. 49) has provision for projectile-type gas checking. The gap between the detonator and lead-in is reduced from 0.058 inch to 0.025 inch for greater assurance of high order functioning. The Mk 164 Mod 0 has a mesh filter covered by a plain flat washer. It is used in 5.0-inch aircraft rockets. To provide for either instantaneous or 0.015-second delay action, Mk 149 nose fuze which can be fired "instantaneous" or "safe" is assembled in the nose of the rocket head. The round which uses the Mk 164 Mod 0 fuze is used against tanks, locomotives, and gun emplacements. Functioning, arming, and performance on impact are the same as those of the detonator-safe Mk 163 Mod 0.



RA PD 116860

Figure 49. Fuze, rocket: base, Mk 164 Mod 0.

78. Fuze, Rocket: Base, Mk 165 Mod 0

This fuze (fig. 50) is used in the 5.0-inch aircraft rocket. It contains the improved shutter and lead-in, and shutter lock assembly as in the Mk 163 Mod 0. The fuze head and fuze-to-motor adapter are made in one piece to improve the seal between the rocket motor and interior of the rocket head. The 5.0-inch aircraft rocket which normally is fired with a Mk 149 nose fuze in the head to permit either instantaneous or 0.02-second delay action, or with the VT fuze. The round is used against personnel and light targets. Arming, functioning on impact, and detonator-safety of the Mk 165 Mod 0 are the same as the Mk 164 Mod 0.

79. Fuze, Rocket: Base, Mk 181 and Mods

The fuze is used with the 2.75-inch high-explosive, antitank rocket head Mk 5.

80. Fuze, Rocket: BDSD, M409

This fuze is a base detonating, shell destroying type used with 2-inch folding fin aircraft rocket M48.

81. Fuze, Rocket: Dummy, M410

This is an inert steel fuze used with the 2-inch aircraft practice rocket M49.



RA PD 116861

Figure 50. Fuze, rocket: base, Mk 165 Mod 0.

82. Fuze, Rocket: Nose Mk 149 Mod 0

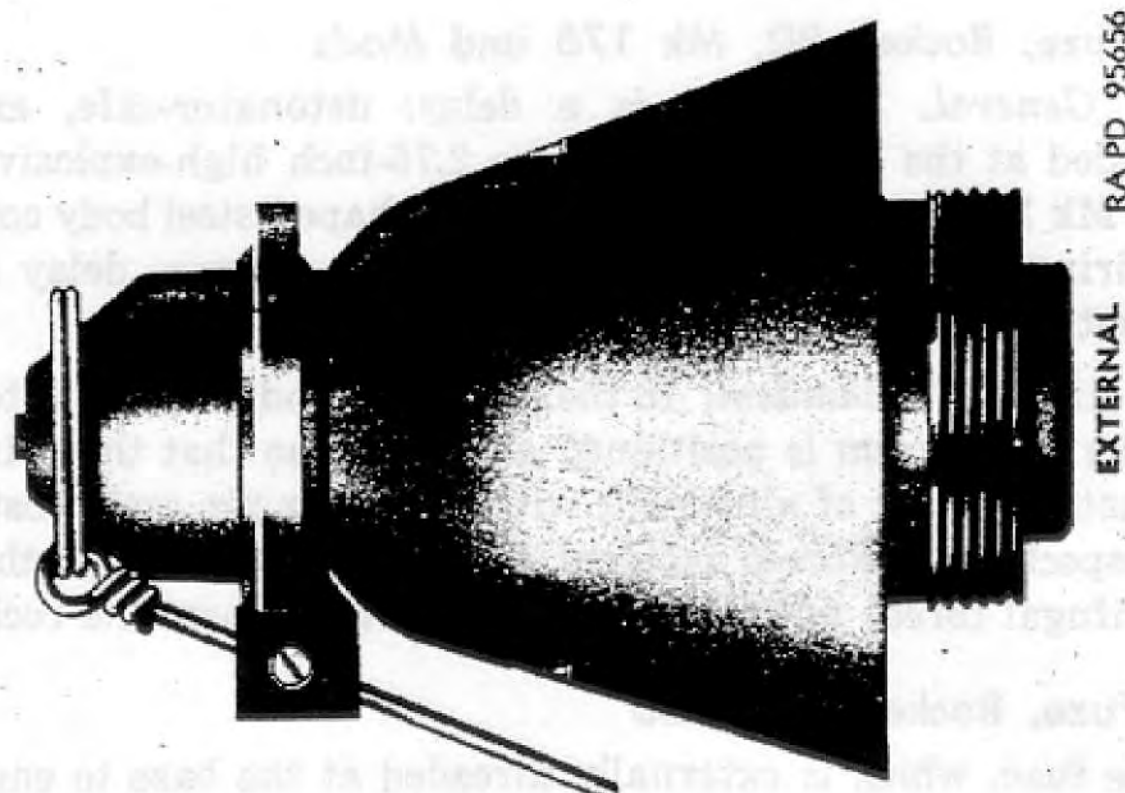
a. General. This is an air-arming, impact-operated fuze for forward-firing aircraft rockets. It is detonator safe and functions with superquick action on impact with ground, water, or plate. It requires the use of an arming wire.

b. Description. This fuze (fig. 51) is streamlined and has a spring-loaded protective cap which protects the propeller and seals the fuze against the weather. The cap is held in position by a split clamp which, in then, is held together by a collar and pin through which the safety wire and arming wire are assembled. The mechanism of the fuze is similar to that of other AIR fuzes described above except that the detonator shutter is held in the safe position by a locking pin controlled by a setback pellet. Thus the detonator cannot move to the armed position until acceleration stops, even if the firing pin has been retracted by propeller action. Arming distance in the 5.0-inch rocket (HVAR), varies from 650 to 1,100 feet.

c. Fuzing.

- (1) Remove fuze from packing and inspect to insure that it is free from serious corrosion or dents and that the threads are clean. If slight corrosion is present, work clamp back and forth so that it slides freely on fuze body and cap. If the fuze is more than slightly corroded, discard it.
- (2) Remove shipping plug from rocket and inspect fuze seat to insure that threads are clean, the auxiliary booster (Mk 3 Mod 1) is in place, and that there is no foreign matter present or other evidence of unserviceability.
- (3) Screw fuze into seat and tighten securely.
- (4) After rocket is placed in launcher, turn clamp so that the safety wire is alined with launcher arming mechanism.
- (5) Thread arming wire through second hole in clamp pin and collar.
- (6) Attach arming wire to launcher arming mechanism. Pull wire through clamp pin so as to take up all slack but not to place any strain on the wire.
- (7) Place one Fahnestock clip on the wire against the collar.
- (8) Cut off excess wire and remove all kinks and burs.
- (9) Remove safety wire from clamp pin.

d. Unfuzing. If the rocket is not used, first replace the safety wire in the clamp pin; then the arming wire may be removed. The rocket may be removed from the launcher and unfuzed. All components should be returned to their original condition and packings.



EXTERNAL RA PD 95656

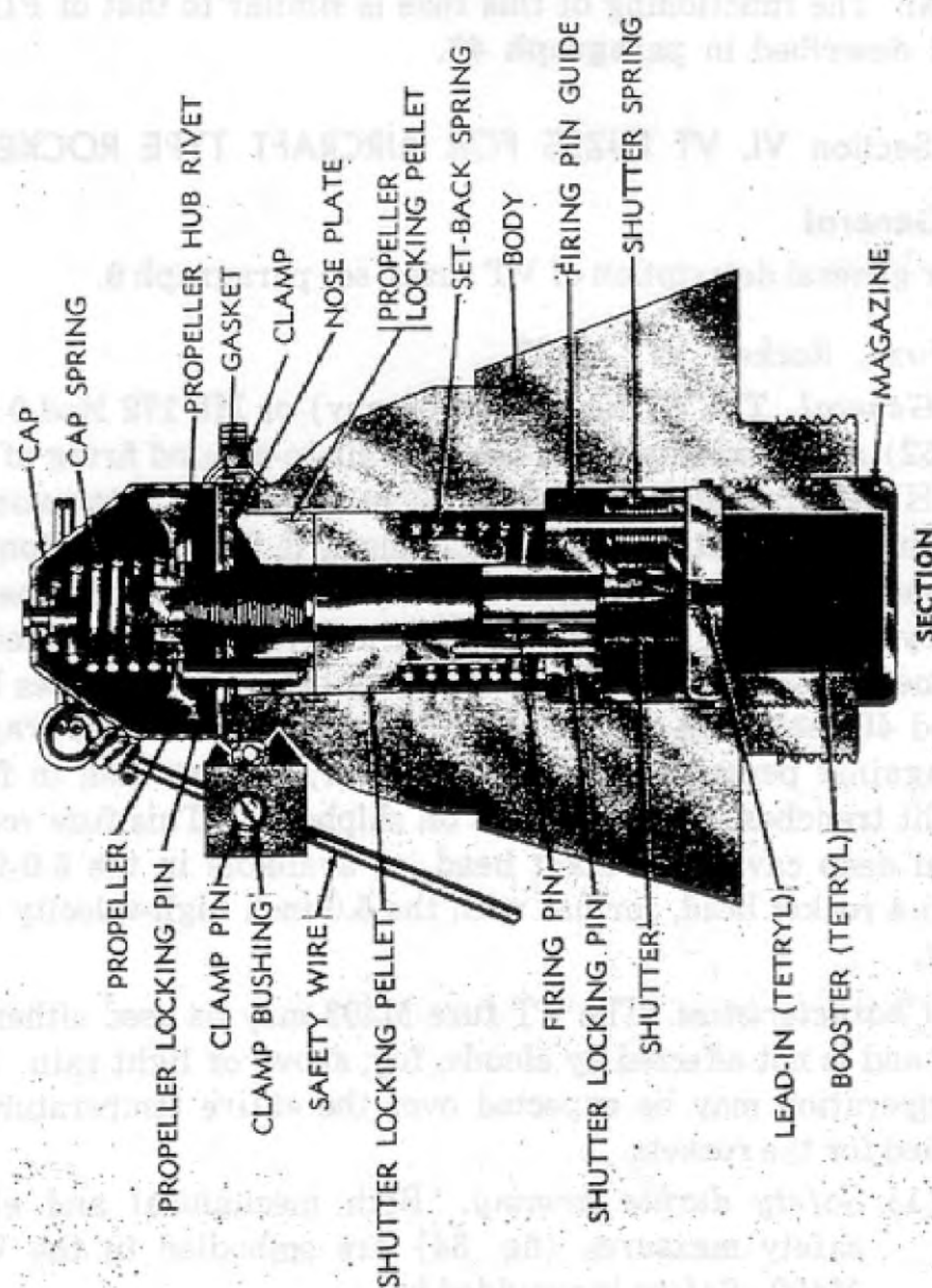


Figure 51. Fuze, rocket: nose, Mk 149 Mods.

83. Fuze, Rocket: PD, Mk 176 and Mods

a. General. The fuze is a delay, detonator-safe, externally threaded at the base to engage the 2.75-inch high-explosive rocket head Mk 1. The fuze consists of a cone-shaped steel body containing the firing mechanism, arming mechanism, primer, delay element, detonator, and booster.

b. Arming Mechanism. In the unarmed condition, the rotor of the arming mechanism is positioned and locked so that the primer and detonator are out of alignment with the firing pin and booster lead-in respectively. Forces incident to firing and flight (setback and centrifugal force) unlock and turn the rotor to arm the rocket.

84. Fuze, Rocket: PI, M406

The fuze, which is externally threaded at the base to engage the 2.75-inch rocket head M1, is an electric type utilizing a piezoelectric crystal. The functioning of this fuze is similar to that of PIBD fuze M408 described in paragraph 46.

Section VI. VT FUZES FOR AIRCRAFT TYPE ROCKETS

85. General

For general description of VT fuzes, see paragraph 9.

86. Fuze, Rocket: VT, M403

a. General. The VT fuze M403 (Army) or Mk 172 Mod 0 (Navy) (fig. 52) are proximity fuzes used for air-to-ground firing of the 5.0-inch HVAR rockets. This fuze is, in effect, an automatically set time fuze. Without any field adjustment, it functions automatically on approach to the target, rather than by impact or time action, thereby causing an air burst to occur at a height determined by the fuze mechanism. Normally, functioning occurs at distances between 10 and 40 feet from the target, causing greatest lethal fragmentation against personnel without top cover, such as men in foxholes, and slit trenches, and gun crews on shipboard. This fuze requires a special deep cavitized rocket head, as available in the 5.0-inch Mk 6 Mod 4 rocket head, for use with the 5.0-inch high-velocity aircraft rocket.

b. Characteristics. The VT fuze M403 may be used either day or night and is not affected by clouds, fog, snow, or light rain. Normal fuze operation may be expected over the entire temperature range specified for the rockets.

- (1) *Safety during arming.* Both mechanical and electrical safety measures (fig. 54) are embodied in the VT fuze M403. Safety is provided by—

(a) An interposed explosive train which is self-actuated by the impact of the rocket motor, and which is actuated after the rocket motor has been fired through the action of the rocket motor.

(b) A rocket motor which is self-actuated by the impact of the rocket motor, and which is actuated after the rocket motor has been fired through the action of the rocket motor.

(c) A rocket motor which is self-actuated by the impact of the rocket motor, and which is actuated after the rocket motor has been fired through the action of the rocket motor.

(d) A rocket motor which is self-actuated by the impact of the rocket motor, and which is actuated after the rocket motor has been fired through the action of the rocket motor.

(e) A rocket motor which is self-actuated by the impact of the rocket motor, and which is actuated after the rocket motor has been fired through the action of the rocket motor.

RA PD 58755



Figure 52. Fuze, rocket: VT, M403.

- (a) An interrupted explosive train, which is safe against dropping and rough handling after the arming wire has been withdrawn, and until the train is alined through the combined effect of air travel and completion of acceleration.
 - (b) An electrical delay system, initiated upon completion of acceleration and closure of fuze firing circuit, which provides detonator safety for an additional period (normally 0.6 to 1.2 seconds).
 - (c) A setback weight in the gear mechanism, operation of which requires approximately 300 feet of air travel under a minimum acceleration of 10g. The setback weight, actuated under proper acceleration, allows the arming shaft to rotate. If the air travel occurs without the required acceleration, safety is not impaired but the fuze will become a dud.
- (2) *Visible indications of mechanical safety.* Various visible indications which attest to the mechanical safety of the VT fuze M403 are—
- (a) The presence of a car seal installed at the loading plant, to insure that the arming vane has not been rotated or tampered with subsequent to loading and prior to use.

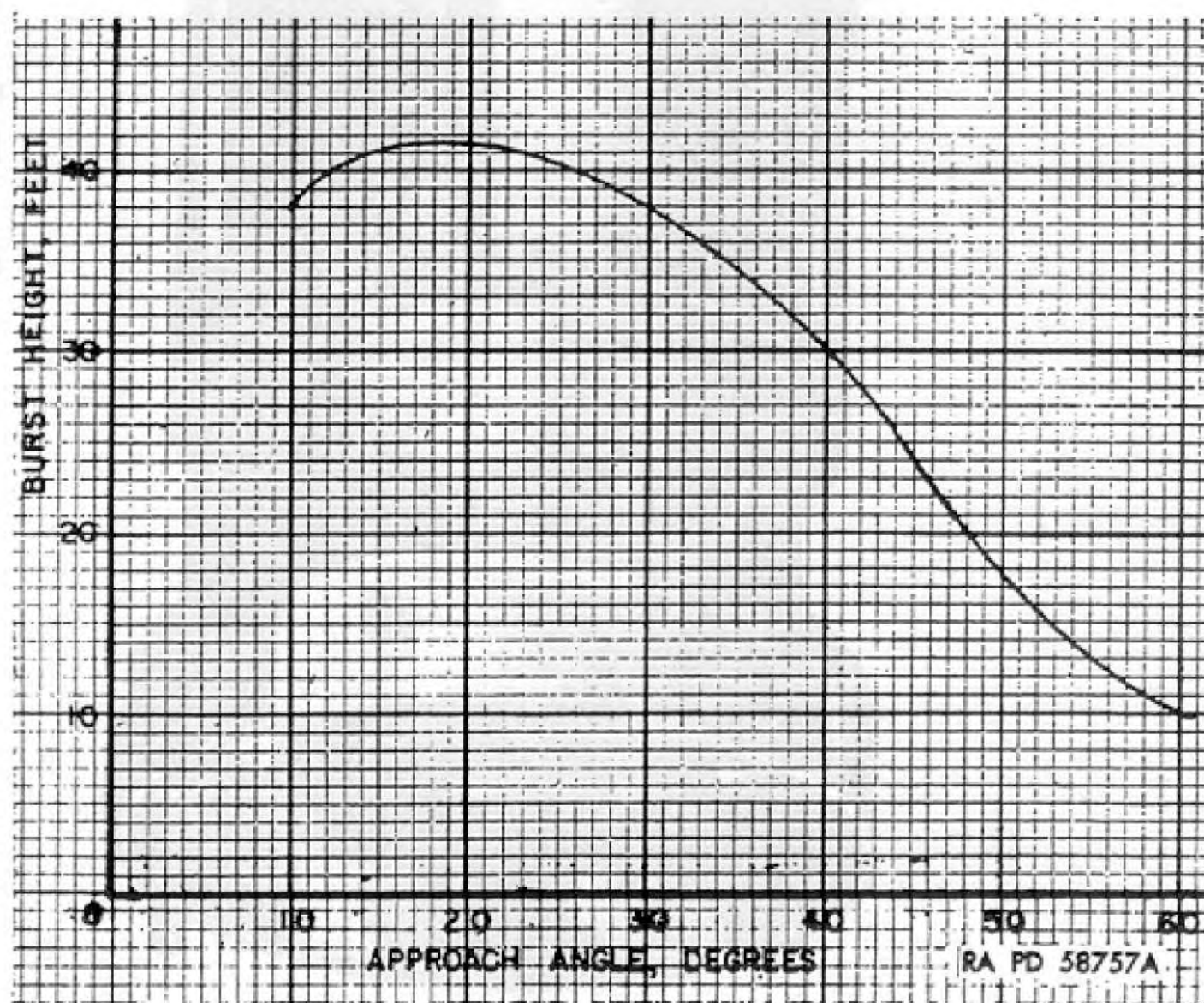


Figure 53. Burst height over average terrain.

(b) A vane locking pin held in place by the arming wire until the moment of firing.

(c) A safety pin inserted alongside the booster cup which indicates safe position of the detonator rotor (fig. 54). The pin extends through the tetryl lead plate and into the rotor. Since a failure of the arming shaft restraining devices would allow the spring-loaded shaft to turn into the armed position, the safety pin should be removed and reinserted and removed again, as instructions on the safety pin tag indicate. If safety pin cannot be reinserted easily, reject the fuze.

(3) *Burst height.* The burst height of the VT fuze M403 in the 5.0-inch rocket varies with dive angle and terrain char-

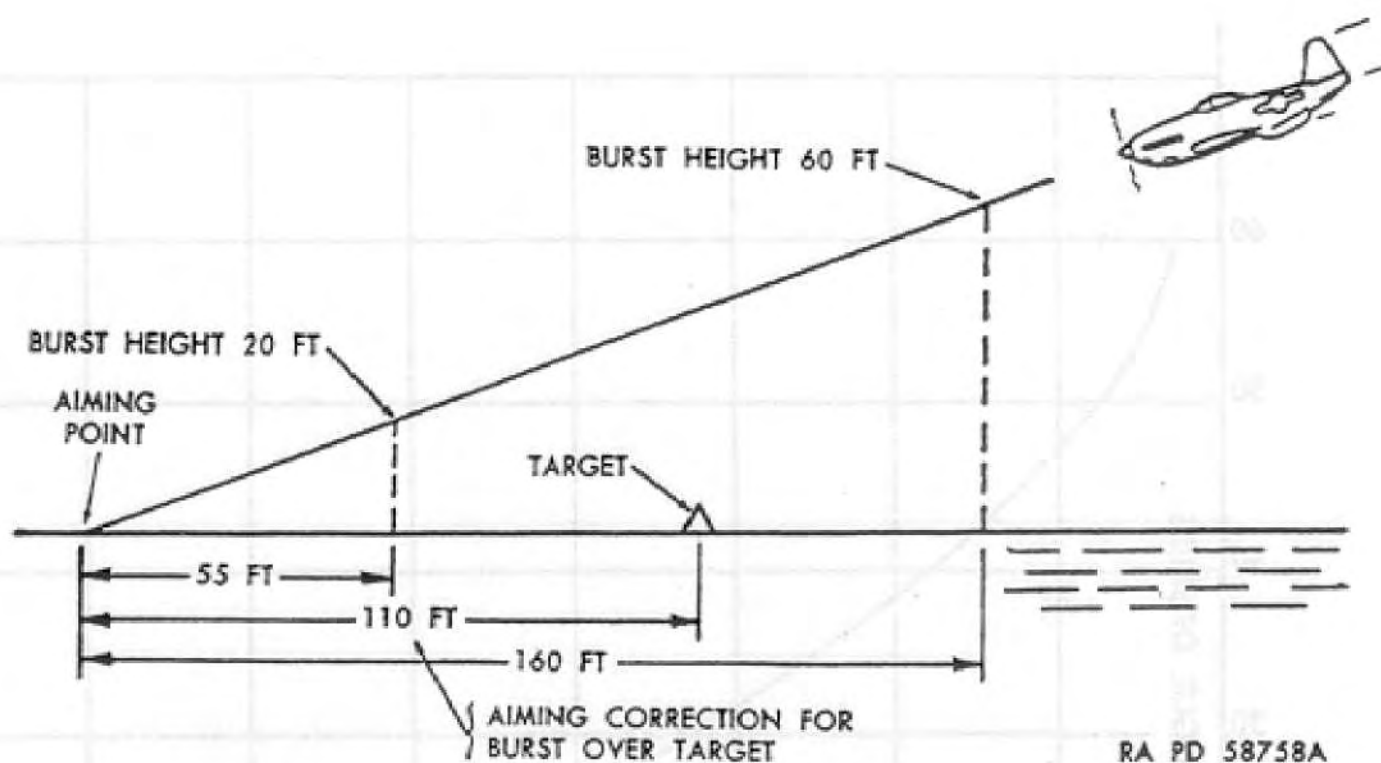


Figure 55. Effect of variation of burst height on range dispersion with 20° dive angle.

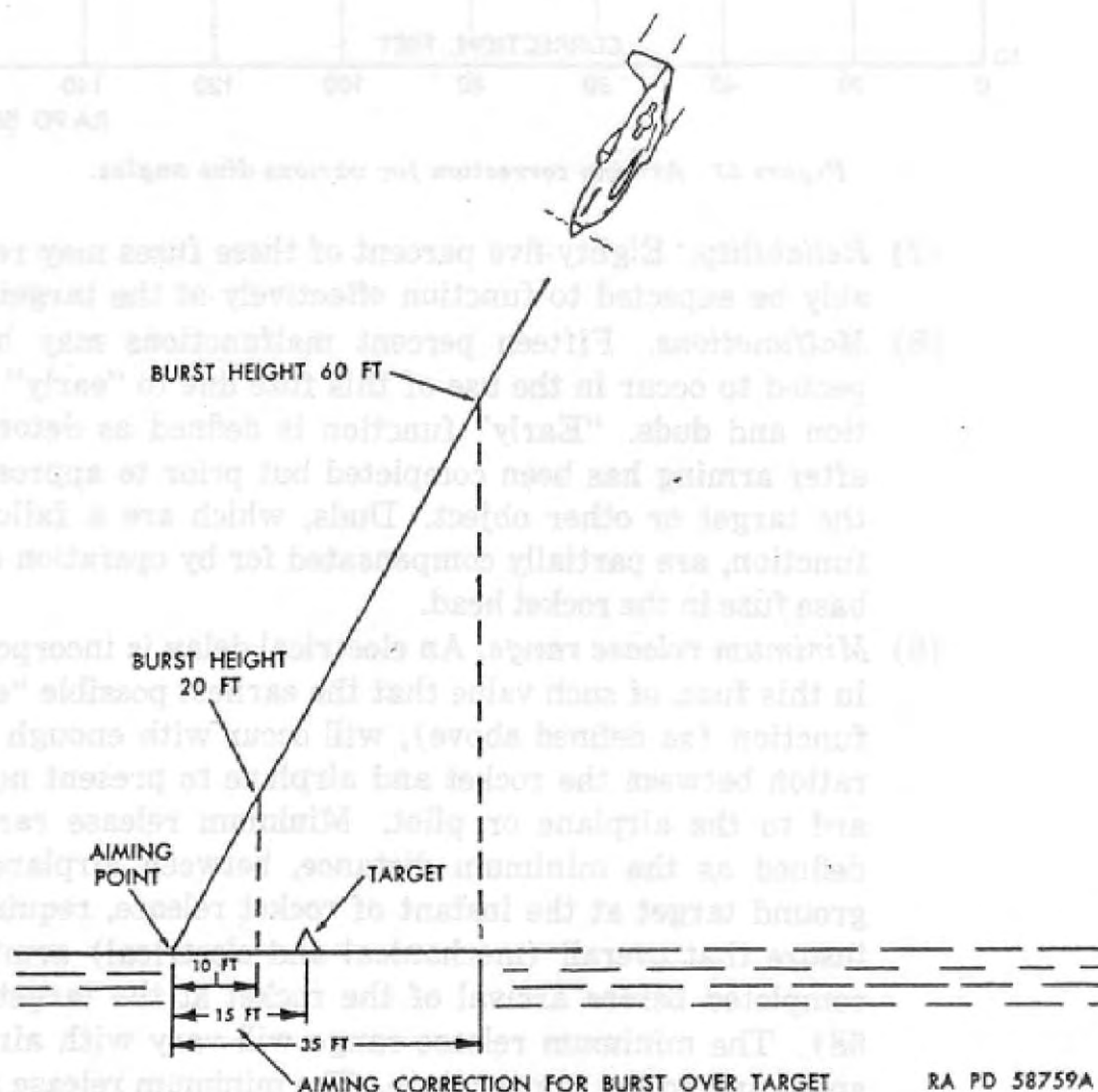


Figure 56. Effect of variation of burst height on range dispersion with 60° dive angle.

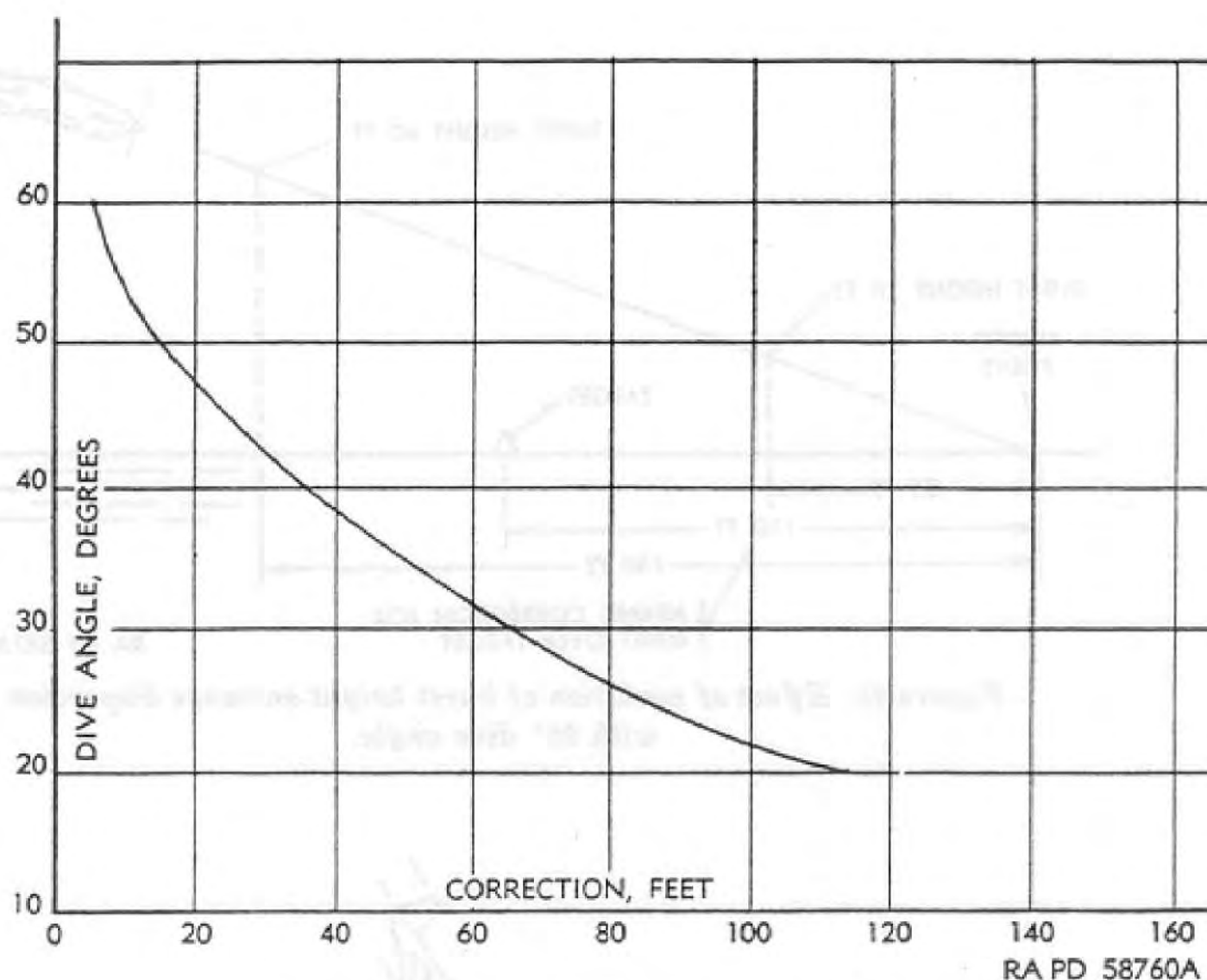


Figure 57. Arming correction for various dive angles.

- (7) *Reliability.* Eighty-five percent of these fuzes may reasonably be expected to function effectively at the target.
- (8) *Malfunctions.* Fifteen percent malfunctions may be expected to occur in the use of this fuze due to "early" function and duds. "Early" function is defined as detonation after arming has been completed but prior to approach to the target or other object. Duds, which are a failure to function, are partially compensated for by operation of the base fuze in the rocket head.
- (9) *Minimum release range.* An electrical delay is incorporated in this fuze, of such value that the earliest possible "early" function (as defined above), will occur with enough separation between the rocket and airplane to present no hazard to the airplane or pilot. Minimum release range is defined as the minimum distance, between airplane and ground target at the instant of rocket release, required to insure that overall (mechanical and electrical) arming is completed before arrival of the rocket at the target (fig. 58). The minimum release range will vary with airplane speed and rocket temperature. The minimum release range when firing VT fuzed 5.0-inch HVAR should never be less than approximately 1,000 yards.

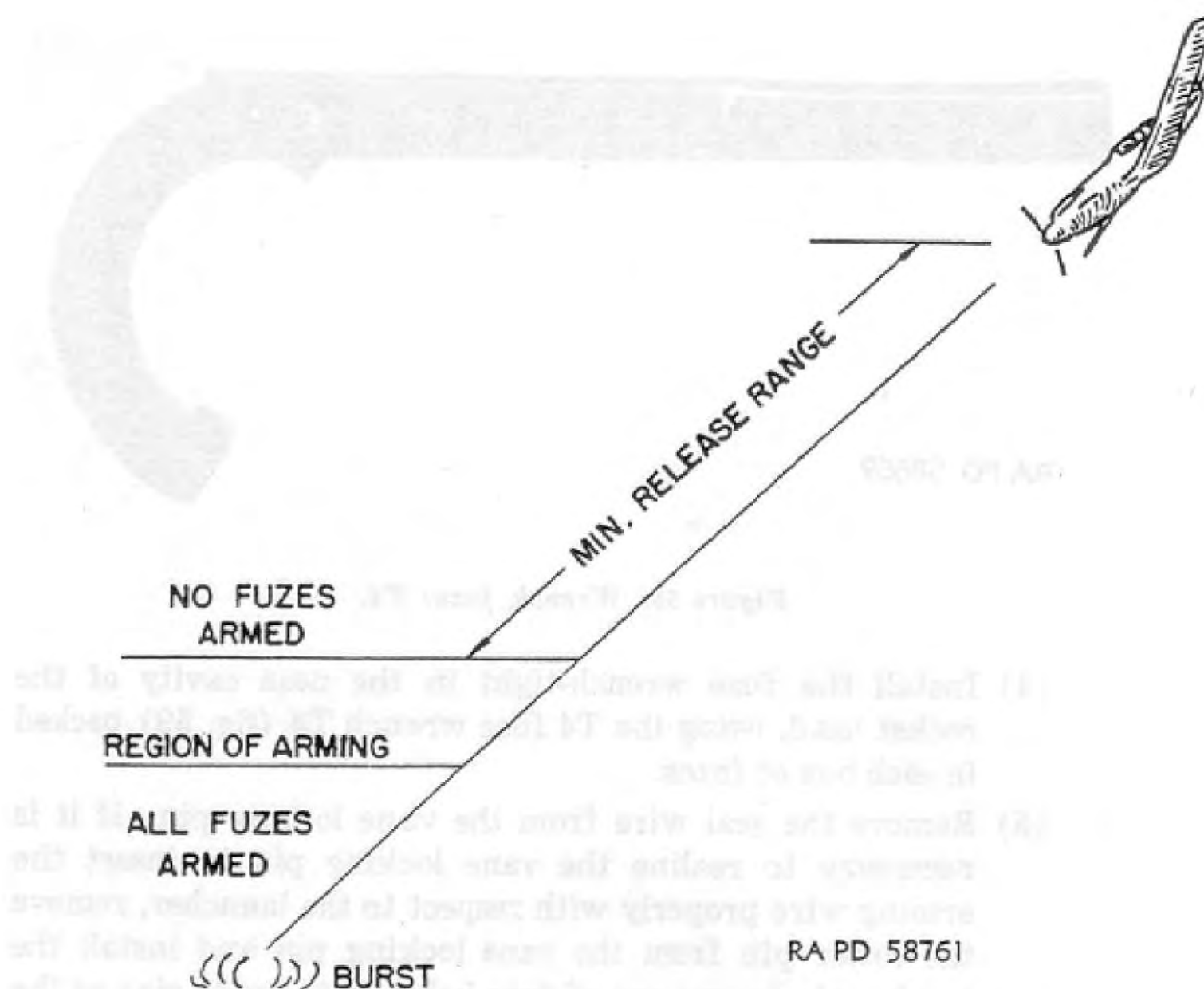


Figure 58. Minimum release range—region of arming.

87. Fuze, Rocket: VT, M403E2

The VT fuze M403E2 is similar to the M403 (par. 86) except that it functions without delay action.

88. Use and Care of VT Fuzes M403 and M403E2

a. Assembly of VT Fuze to Rocket.

- (1) Remove the fuze from its container and inspect for broken seal or defects, such as bent arming vane, loose parts, dents, etc.
- (2) Inspect the rocket assembly. See that the fuze well is free of dirt, rust, or other foreign material. See that the head, motor, and fins are tight. Do not use rockets with bent or damaged fins.
- (3) Remove the rear safety pin from the booster cup (refer to instruction tag), and check to see that the pin is not bent or sheared. Reinsert the safety pin to check the unarmed position of the interrupter rotor. If the safety pin does not insert easily, reject the fuze. Remove the safety pin again and retain it, since in case the round is to be disassembled, the pin will be required.



RA PD 58669

Figure 59. Wrench, fuze: T4.

- (4) Install the fuze wrench-tight in the nose cavity of the rocket head, using the T4 fuze wrench T4 (fig. 59) packed in each box of fuzes.
- (5) Remove the seal wire from the vane locking pin. If it is necessary to realine the vane locking pin to insert the arming wire properly with respect to the launcher, remove the cotter pin from the vane locking pin and install the locking pin in any one of four holes on the nose ring of the fuze.
- (6) Install the arming wire through the hole from which the seal wire was removed (the hole inside, nearest the arming vane, fig. 60). Pull the arming wire through the hole until it extends 3 to 4 inches beyond the fuze. Then remove the cotter pin from the vane locking pin, allowing wire to hold the vane locking pin in place.

Caution: Do not use Fahnestock clips with these fuzes.

b. *Disassembly Procedure.* If use of the fuzed rocket is not likely for 48 hours, the fuze should be removed as follows:

- (1) Replace the cotter pin in the hole nearest the head of the vane locking pin. If necessary, press in on the head of the vane locking pin to expose the hole. Remove the arming wire.
- (2) Remove the fuze from the rocket head, using the fuze wrench T4. An unarmed fuze cannot fire and is entirely safe to handle and remove from rocket.
- (3) Replace the safety pin in the booster cup. If the pin cannot be inserted easily, discard the fuze.
- (4) Replace the fuze in its shipping can and seal the lid of the can with friction tape.

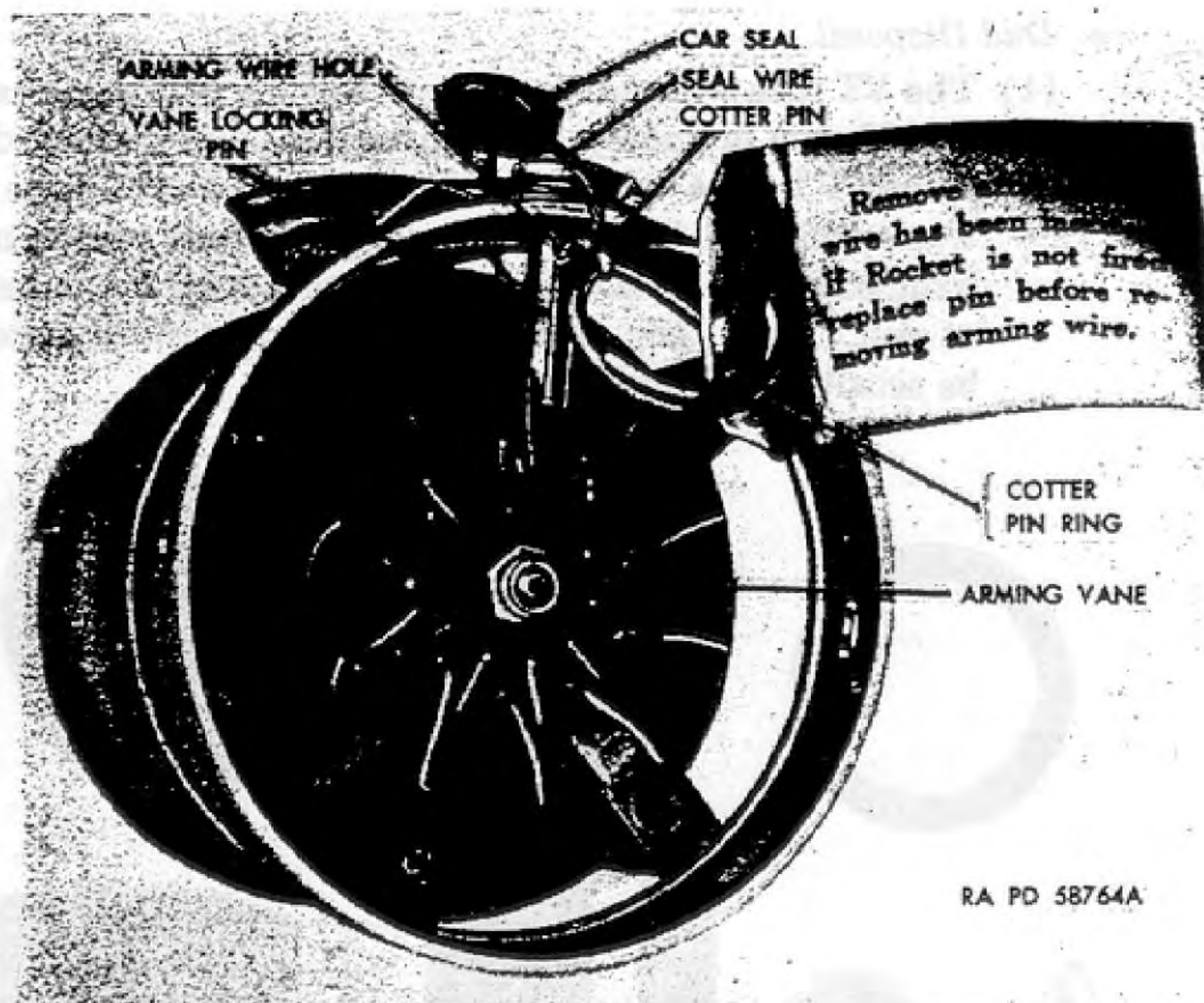


Figure 60. Fuze, rocket, M403—vane, locking pin, seal wire with car seal, and cotter pin, in place as shipped in container.

c. Storage and Handling.

- (1) *Packaged fuzes.* Fuzes may be stored for extended periods of time and are not affected adversely by temperatures between 40 and 140° F. when in the original containers and if unopened.
- (2) *Unpackaged fuzes.* Exposure to high humidity atmosphere tends to deteriorate unpackaged fuzes. Fuzes should be unpacked only in quantity sufficient to meet the immediate need. Fuzes which are not to be used within 48 hours should be returned to storage, repacked in their original containers with the lids taped securely. Such fuzes should be used first, before opening sealed containers.
- (3) *Handling.* VT fuzes, as originally packed, may be subjected to the same handling as other fuzes. Dropping normally will not damage a packaged fuze, but dropping may damage an unpackaged fuze. Rough or abusive handling of the fuzes may tend to increase malfunctions but will not decrease the safety of the fuze. Damaged fuzes should be set aside for destruction.

d. Demolition of VT Fuzes. See paragraph 99.

e. Dud Disposal.

- (1) The VT fuze will not fire unless the vane is turning rapidly (2,000 rpm or more), even though the fuze is armed. An armed VT fuze which has been damaged while the vane was turning at high speed is dangerous and should not be handled until at least 60 minutes have elapsed with the vane at rest. Before the expiration of 60 minutes, the fuze may be sensitive to shock, jar, or approach.

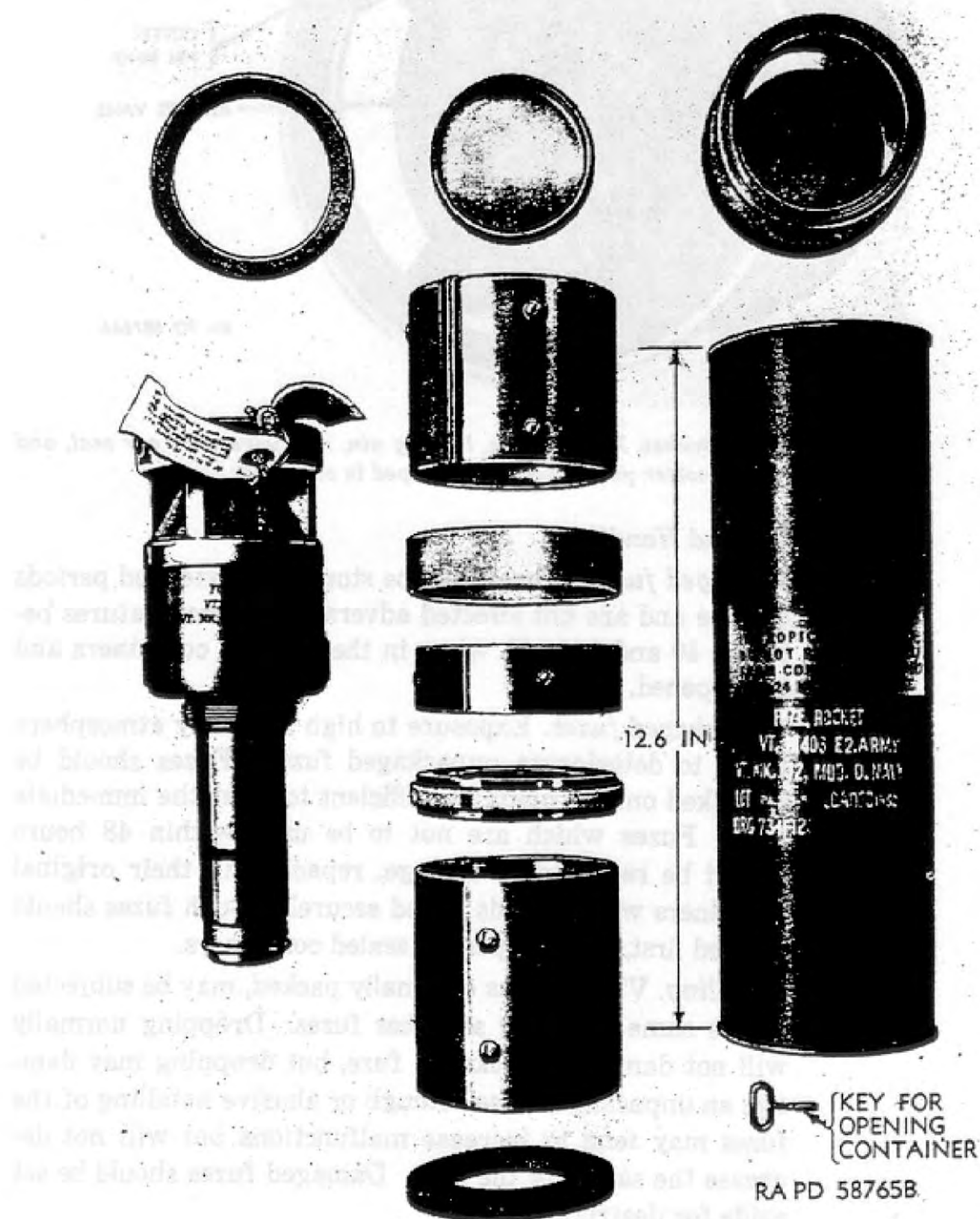


Figure 61. Fuze, VT, M403—with container and interior container mountings.

- (2) Dud disposal should be accomplished by authorized bomb disposal personnel. It should never be attempted by unauthorized personnel.

f. Packing and Marking. VT fuzes are packed in hermetically sealed cans. Nine such cans are packed per wooden box. A special fuze wrench is packed in each box to be used in assembly and disassembly of the fuze to the rocket head.

(1) *Packing data.*

Fuze weight.....	4.5 lb
Overall diameter of fuze.....	3.4 in.
Overall length of fuze.....	10.4 in.
Length of fuze extending beyond fuze well.....	5.0 in.
Number of fuzes in box.....	9
Weight of box.....	77 lb
Dimensions of box.....	14 x 15 $\frac{3}{8}$ x 15 $\frac{1}{2}$ in.
Volume of box.....	2 cu ft

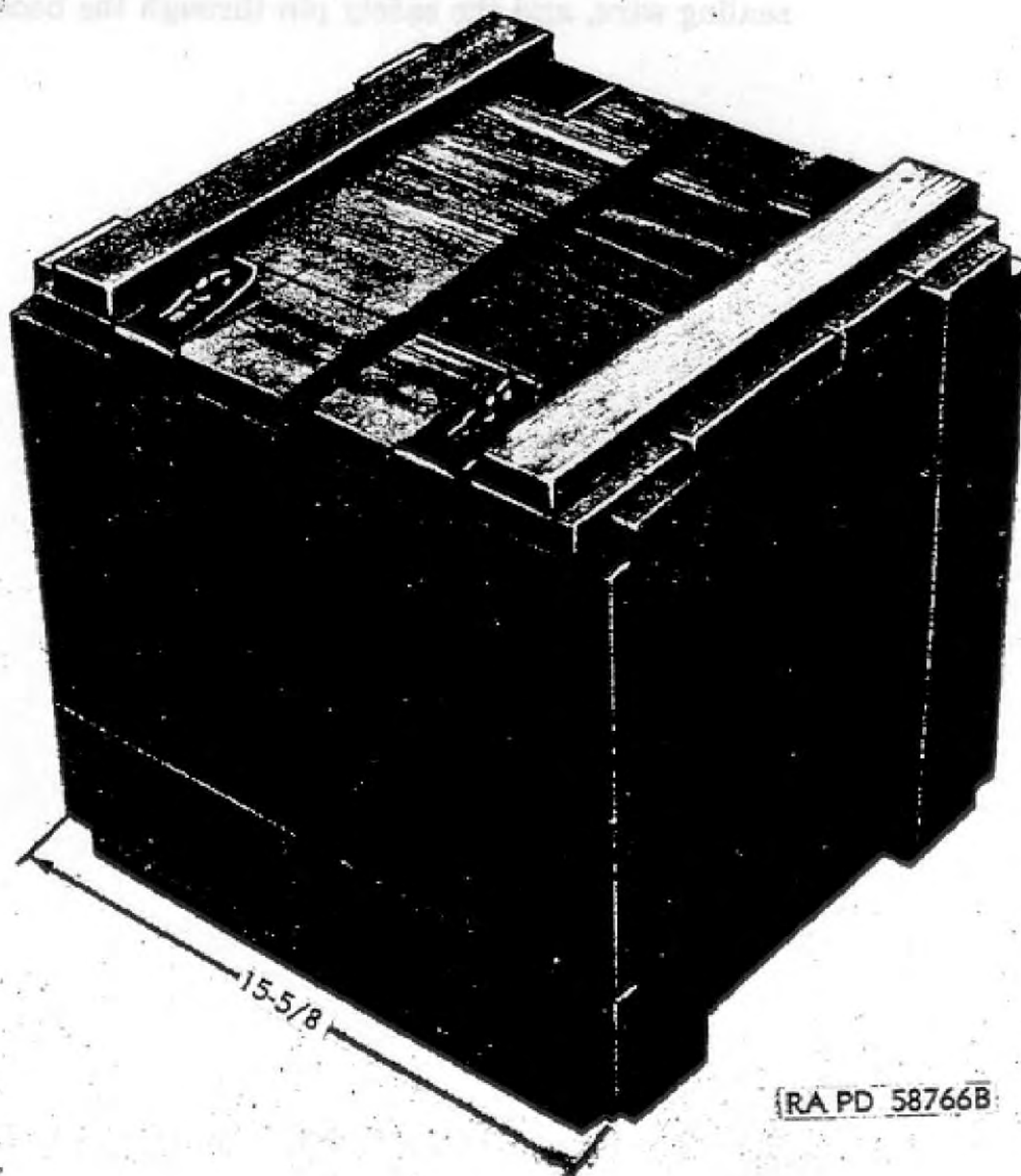


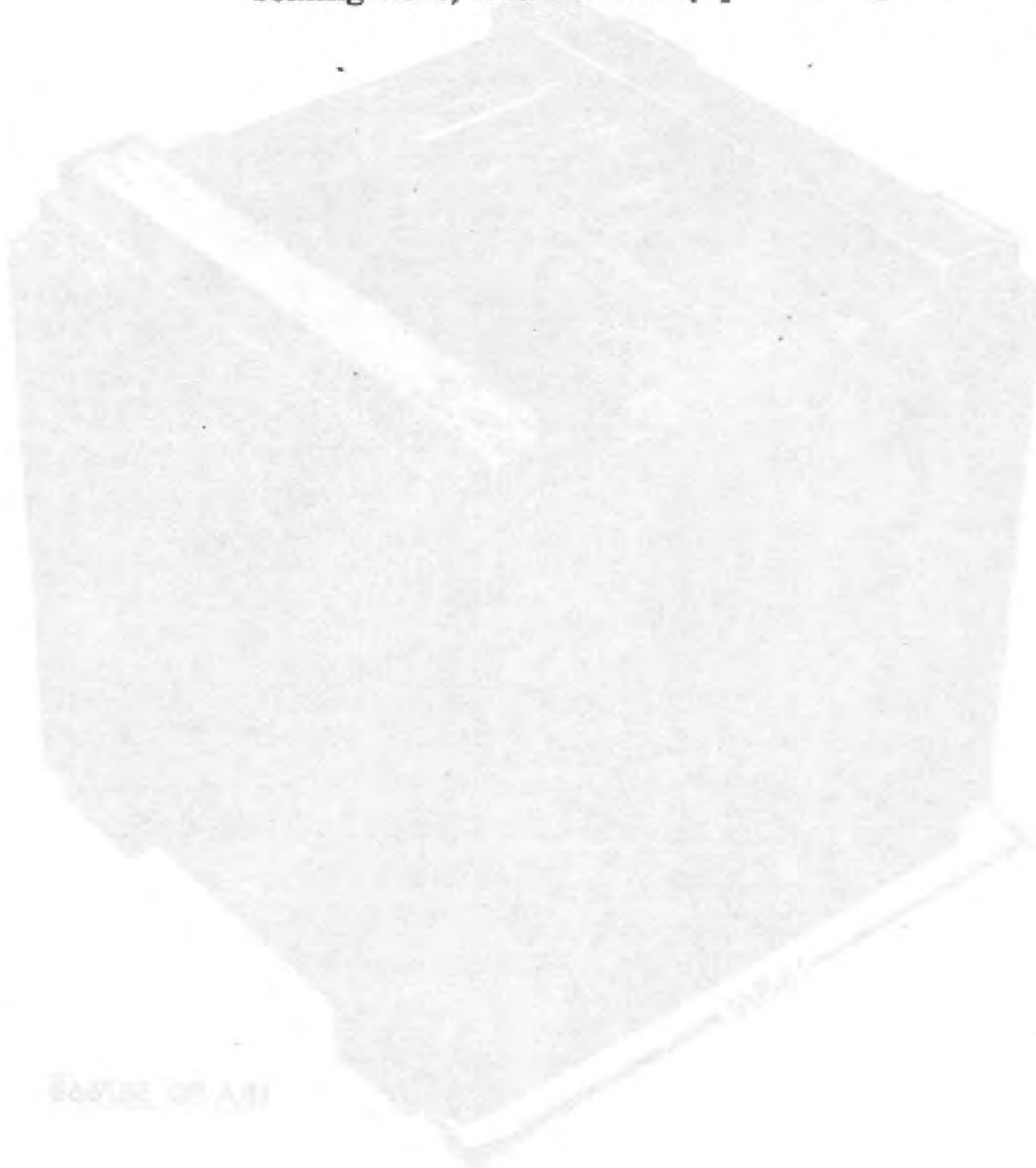
Figure 62. Packing box for VT fuze M403.

(2) *Packaging.* Fuzes are supported within their respective metal containers (fig. 61) by rubber, plastic, and metal mountings. These mountings should be removed from the fuze before assembling it to a rocket projectile.

(3) *Marking.*

(a) Each packing box (fig. 62) is stenciled with nomenclature, quantity, lot number, date loaded, weight, cubage, Federal stock numbers, and shipping data.

(b) Each fuze and container is stamped or stenciled with nomenclature, lot number, date of loading, and Federal stock numbers. If the item or container is too small to accommodate the complete number, the Department of Defense Identification Code (a 4-place number consisting of a letter and three numbers) is used. Instruction tags are attached to the vane locking cotter pin, the sealing wire, and the safety pin through the booster cup.



CHAPTER 4

SOLID ROCKET PROPELLANTS

89. General

a. General Discussions. In order to apply the rocket principle described in paragraph 4, it is necessary to provide a potentially powerful compact substance in the rocket motor which, when ignited, will provide a source of gas at high pressure for a stated period of time. Such substance is the rocket propellant. Rocket propellant may be liquid or solid. Liquid propellant may consist of a fuel component such as alcohol or hydrazine and an oxidizer such as liquid oxygen or red fuming nitric acid. The rockets described in this manual are of the ordinary military type and use either double-base or composite solid propellant. Double-base solid propellant consists essentially of a physical mixture of nitrocellulose and nitroglycerin extruded or cast into a single propellant element called a grain. The nitroglycerin and nitrocellulose embody both fuel and oxidizer. Composite propellants contain neither nitrocellulose nor nitroglycerin, consisting generally of a physical mixture of an organic fuel such as ammonium picrate, an inorganic oxidizing agent such as potassium nitrate, and an organic binding agent. When ignited by the propellant explosive train described in paragraph 7, the solid propellant burns using the self-contained oxygen and is transformed into gas. The rate of gas formation depends on the burning rate which is controlled by the composition of the propellant and the shape of the grain. See TM 9-1910 for detailed discussion of propellants.

b. Double-Base Propellant Compositions. Double-base solid rocket propellants used with military rockets described in this manual are classified as to their composition as "solventless" or "solvent." Both types consist of nitrocellulose gelatinized by nitroglycerin and solvents or by nitroglycerin alone to form a tough homogenous substance similar to plastic.

- (1) *Solventless.* The propellant compositions M13, M16 (T6), and JPN ballistite (Navy propellant grains) are of the "solventless" type. These propellants consist essentially of nitrocellulose and nitroglycerin. Solventless propellant is finished into grains by extruding rolls (carpet rolls) of sheet propellant through dies. See table IV and TM 9-1910.

- (2) *Solvent.* The propellant composition M7 is of the solvent type. It differs from the "solventless" type chiefly in the use of volatile solvents in the manufacturing process. Solvent propellant is produced by extruding blocks of the propellant through dies and then drying to remove the volatile solvent. The solvent propellant manufacturing process is used only when making grains of small web (thickness) due to the difficulty encountered in removing the solvent from grains having a large web. See table IV and TM 9-1910.

Table IV. Propellant Compositions

Constituent	Solvent		Solventless	
	M7 (%)	M13 (%)	M16 (T6) (%)	JPN Ballistite (%)
Nitrocellulose.....	54.6	57.3	55.5	59*
Nitroglycerin.....	35.5	40.0	27.5	41*
Potassium perchlorate.....	7.8			
Potassium sulfate.....		1.5	1.5	
Carbon black.....	1.2	0.05	0.05	
Dinitrotoluene.....			10.5	
Lead stearate.....			0.5	
Diphenylamine.....		0.2		
Ethyl centralite.....	0.9	1.0	4.0	

* Approximate.

c. *Composite Propellant Compositions.* Composite propellants are uncolloided, heterogeneous mixtures. A representative type composition consists of ammonium picrate, potassium nitrate, ethyl cellulose, chlorinated wax, and calcium stearate. These compositions are manufactured by a simple mixing operation and moulded in the desired form by pressing.

d. *Propellant Grains.* Propellant grains (fig. 63) are classified according to their shape as cruciform, single perforated, and single perforated (ribbed). The rocket propelling charge consists of one large propellant grain or as many as 30 smaller grains.

- (1) *Model number.* Propellant grains of Navy manufacture are provided with model numbers (Mk and Mods); Army propellant grains, have no model number but may be identified by the propellant composition e.g., M7 or M16 (T6).

- (2) *Web.* The critical dimension of the grain is the "web" thickness, which is the minimum distance between any two

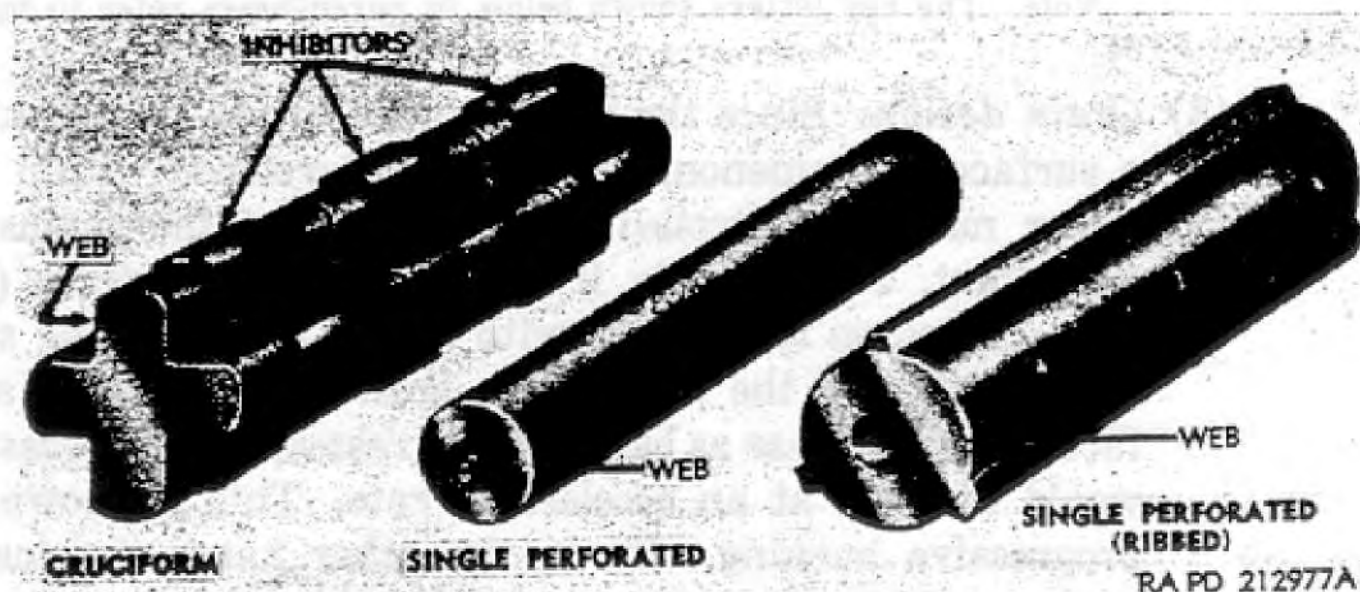


Figure 63. Rocket propellant grains.

adjacent surfaces of the grain (fig. 63). In cruciform grains the web is the thickness of each arm. In single perforated grains, it is the difference between the inner and outer radius.

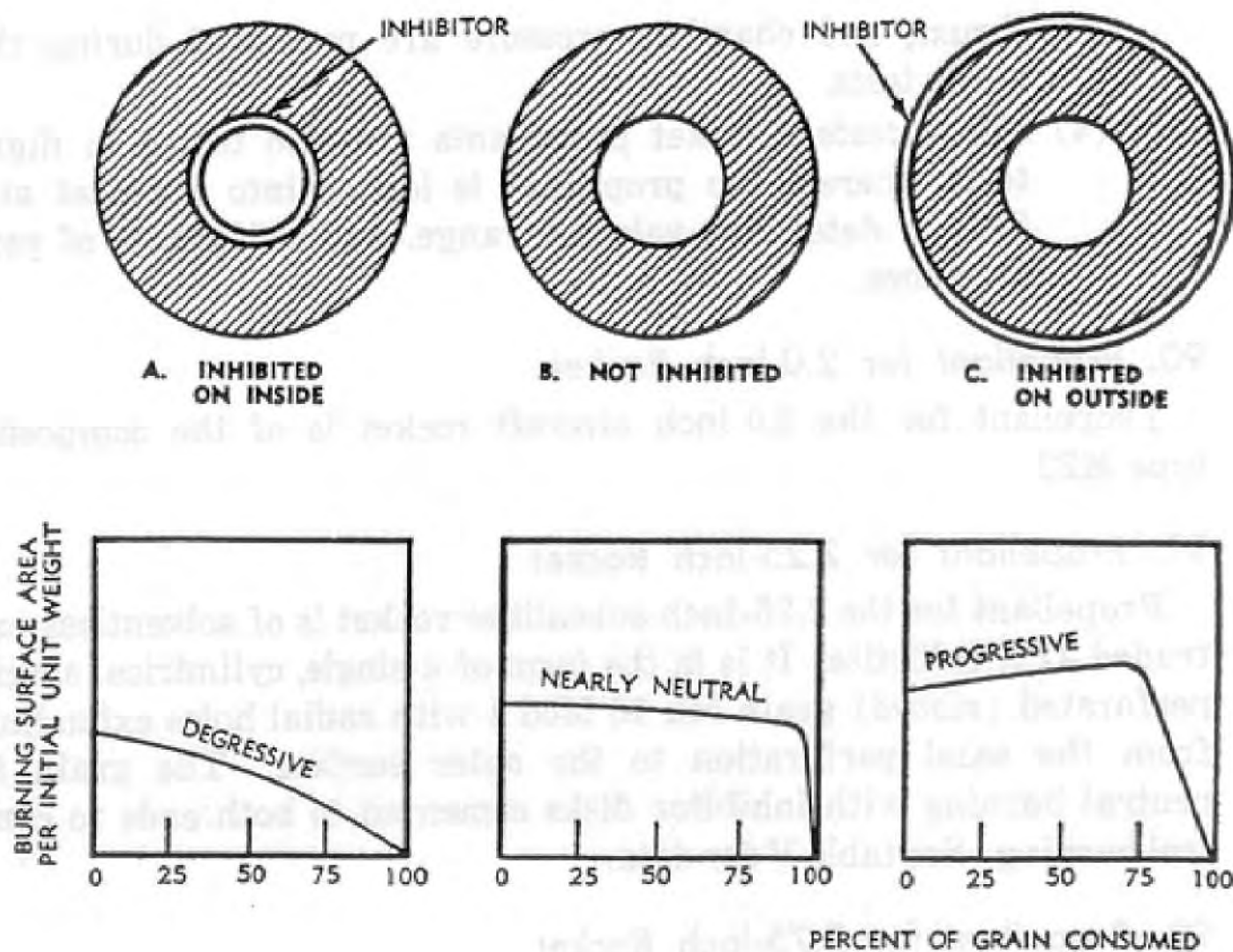
- (3) *Inhibitors.* Inhibitors, sometimes called deterrents (fig. 63), are slow burning materials, such as cellulose acetate, covering the surface of propellant grains to decrease the rate of burning on that surface. See *e*(3) below.

e. Interior Ballistics.

- (1) *General.* The thrust developed by the burning of the propellant is one of the factors considered by interior ballistics which relates to the phenomena associated with imparting motion to projectiles (rockets). The thrust developed by the propellant is effected by the burning characteristics, grain design, K factor, and specific impulse.
- (2) *Burning characteristics.* Double-base propellant is suited particularly for use as a rocket propellant because of its chemical composition and surface burning property. When ignited, burning takes place over its exposed surface and progresses in a direction perpendicular to those surfaces one layer at a time. The burning time depends upon the composition of the propellant, the shape of the propellant, the initial temperature, and pressure within the motor. Burning rate increases with the increase of pressure and temperature. For example, with an initial propellant temperature of 70° F., the burning rate may vary from 0.20-inch per second at atmospheric pressure (14.7 psi) to 1.30 inches per second when confined in a rocket motor at a pressure of 1,000 psi.

Note. The key letters shown below in parentheses refer to figure 64.

- (3) *Grain design.* Since the burning rate of the propellant is a surface phenomenon, the pressure developed within the motor may be controlled by the design of the grains of propellant. For example, if a single perforated grain (B) were coated on the outside with a very slow burning substance (C) and the inside were ignited, the burning surface would increase as burning progressed, so that pressure would increase at an accelerated rate. This is known as progressive burning. If, on the other hand, the inside surface of the grain were coated (A) and the outside surface ignited, the outside surface would decrease as burning progressed, so that pressure would increase at a decelerating rate. This is known as degressive burning. If neither the inside nor the outside were coated (B) the decrease in burning area on the outside would be offset by the increase in burning area on the inside, and the burning area would be constant. Thus, by grain design and by the use of coatings, called inhibitors or deterrents, it is possible to control the burning surface of the grains to obtain the desired burning time for the propellant charge. Cellulose acetate, in a thin layer, generally is used to coat propellant surfaces and restrict burning.
- (4) *K factor.* The ratio of the propellant burning surface to the area of the rocket nozzle is known as the K factor. In order to assure proper propulsive action, it is important that this factor be controlled. If the K factor should increase appreciably as the result of voids or fissures in the propellant grains, grain cracking, or blocking of the nozzle, sufficient excess pressure might develop in the motor to burst it.
- (5) *Specific impulse.* Impulse is the product of the thrust (1b) and the time (sec) over which the thrust acts. The unit is pound-second. Specific impulse is the impulse per unit weight of propellant. The specific impulse may be considered as the pounds of thrust developed per pound of propellant consumed per second and can be used for comparison of rocket compositions. It is also known as the *performance index*. As the space in a rocket motor available for propellant is limited, the density of the propellant is important and specific impulse may be calculated on both a unit weight and unit volume basis. The solvent propellant M7 has a specific impulse of 237 pound-seconds per pound



RA PD 212980

Figure 64. Comparative burning of single perforated propellant grains.

of propellant and the solventless propellant M13 a specific impulse of 242.

f. Propellant Testing. Rocket propellants are tested to insure their stability in storage and uniformity and quality of performance.

- (1) *Surveillance test, 65.5° C.* This test is to check stability. A sample of propellant in a glass stoppered bottle is subjected to a temperature at 65.5° C. and checked daily for dangerous decomposition as indicated by the appearance of red fumes. If a sample decomposes in 20 days or less, the propellant lot is considered hazardous and the propellant destroyed.
- (2) *Heat tests.* Propellant is also tested at a temperature of 120° C. for stability. The initial decomposition of the propellant is indicated by the appearance of a salmon pink color on normal methyl violet test paper. Testing at 120° C is continued after the salmon pink color appears until the appearance of red fumes and ultimately until the propellant bursts into flame.
- (3) *Static tests.* Propellant performance is tested in static tests wherein a sample of propellant is fired in a test motor secured in place to prevent movement. Burning time,

thrust, and chamber pressure are measured during the static tests.

- (4) *Flight tests.* Rocket propellants are also tested in flight tests wherein the propellant is loaded into a rocket and fired to determine velocity, range, and uniformity of performance.

90. Propellant for 2.0-Inch Rocket

Propellant for the 2.0-inch aircraft rocket is of the composite type M22.

91. Propellant for 2.25-Inch Rocket

Propellant for the 2.25-inch subcaliber rocket is of solventless extruded JPN ballistite. It is in the form of a single, cylindrical single perforated (ribbed) grain Mk 16 Mod 1 with radial holes extending from the axial perforation to the outer surface. The grain is neutral burning with inhibitor disks cemented to both ends to control burning. See table V for data.

92. Propellant for 2.75-Inch Rocket

Propellant for the 2.75-inch rocket is of solventless extruded ballistite. The propellant is in the form of an internal (progressive) burning single perforated grain inhibited on the outer surface. See table V, for data.

93. Propellant for 3.5-Inch Rocket

a. *Rockets M35, M35A1, and M36.* Propellant for these 3.5-inch rockets is of the solvent extruded type M7. It is in the form of 19 single perforated, cylindrical grains supported on suspension screws in the head end of the motor and by a cushioning ring near the tail end. The propellant, of the neutral burning type, burns in relatively short time and is completely consumed at all operating temperatures, while the rocket is in the launcher. See table V, paragraph 96 for data.

b. *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30.* Propellant for these 3.5-inch rockets is of the solvent extruded type M7. It is in the form of 12 single perforated, cylindrical grains, positioned three in each of the four compartments into which the spacer divides the motor. The propellant, of the neutral burning type, burns in relatively short time in order to be consumed before the rocket leaves the launcher. See table V for data.

94. Propellant for 4.5-Inch Rocket (Expendable Launcher)

Propellant for the 4.5-inch rocket (expandable launcher) is of the solventless extruded type M13. It consists of 30 neutral burn-

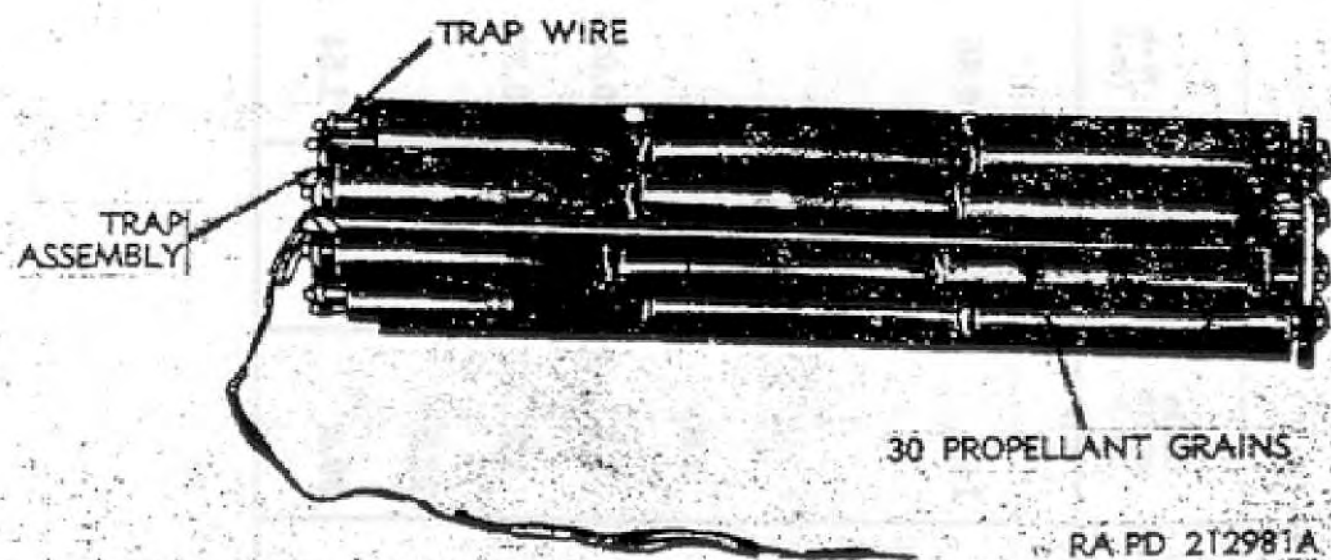


Figure 65. Propellant for 4.5-inch rocket (expendable launcher) arrangement.

ing, single perforated cylindrical grains supported on the wires of the trap assembly (fig. 65). See table V for data.

95. Propellant for 4.5-Inch Rocket (Multiple Launcher Type)

The propellant for the 4.5-inch rocket (multiple launcher) M32, M33, and T164E1, is of the solventless extruded type M16 (T6). It is in the form of seven neutral burning, single perforated cylindrical grains which are taped together before loading in the motor. Propellant for the 4.5-inch rockets M16 (series) and M17 (series) is similar to that described in paragraph 94. See table V for data.

96. Propellant for 5.0-Inch Rocket (HVAR)

The propellant for the 5.0-inch rocket (HVAR) is of solventless extruded JPN ballistite. It is in the form of a cruciform inhibited grain Mk 18 Mod 0. See table V for data.

Table V. Rocket Propellant Data

Caliber of rocket	Propellant composition or model of grain ¹	Type of composition	Type of grain	Grains per rocket	Weight of propellant (lbs)	Grain length (in.)	Grain outside diameter (in.)	Web (in.)
2.0-inch	M22 Mk 16 Mod 1	Composite Solventless	Single perforate (ribbed)	1	1.75	14.0	1.97	0.85
2.25-inch			Single perforate	1				
2.75-inch	Mk 31 Mk 43 and Mk 43 Mods	Solventless	Single perforate	12	0.35 ²	5.0	0.38	
3.5-inch (old-type)	M7	Solvent	Single perforate	19	0.44	5.7	0.33	0.096
3.5-inch (new-type)	M7	Solvent	Single perforate	30	4.81	5.3	0.88	0.30
4.5-inch (expendable launcher)	M13	Solventless	Single perforate	7	7.78 ³	13.5		
4.5-inch (multiple launcher)	M16 (T6)	Solventless	Single perforate	1	23.9	39.2	4.53	1.54
5.0-inch (HVAR)	Mk 18 Mod 0	Solventless	Cruciform					

¹ Grains with "Mk" and "Mod" numbers are of JPN ballistite composition.

² Early manufacture 0.36 pounds.

³ M16 (series) and M17 (series) rockets have the same propellant as expendable-type 4.5-inch rockets.

CHAPTER 5

DEMOLITION TO PREVENT ENEMY USE

97. General

a. Demolition of rockets described herein, when subject to capture or abandonment in the combat zone will be undertaken by the using arm only when, in the judgment of the unit commander concerned, such action is necessary in accordance with orders of, or policy established by, the army commander.

b. The information which follows is for guidance only. The conditions under which demolition will be effected are command decisions and may vary in each case dependent upon a number of factors such as the tactical situation, security classification of the rockets (AR 380-5 and AFR 205-1), quantity and location of the rockets, facilities for accomplishing demolition, and time. In general, demolition of rockets can be accomplished most effectively by burning or detonation, or a combination of these. Selection of the particular method of demolition requires imagination and resourcefulness in utilization of the facilities at hand under the existing circumstances. Time is usually critical.

c. If demolition to prevent enemy use is resorted to, rockets and their components must be so badly damaged that they cannot be restored to a usable condition in the combat zone either by repair or cannibalization. However, when lack of time and personnel prevents demolition of all components, priority is given to the demolition of those components most difficult to replace. Equally important, the same essential parts on all rockets must be destroyed so that the enemy cannot construct one complete rocket from several partly damaged rockets.

d. If demolition of rockets is directed, due consideration should be given to—

- (1) Accomplishment of the demolition in such a manner as to cause the greatest obstruction to enemy movement and also prevent hazard to friendly troops from fragments or uncontrolled flight of rockets.

- (2) Observance of appropriate safety precautions.

98. Methods

Rockets, rocket heads, and rocket motors can be most quickly

destroyed by detonation or burning. In planning and accomplishing the demolition of rockets, rocket heads, and rocket motors, due consideration should be given to the propulsive nature of the rocket motor which, when ignited, will project the rocket in the direction that it is pointed. Unless restrained at the time of ignition, rockets are projected in unpredictable flight. Suitable cover is important, not only to protect from fragments but also from the rocket itself. To minimize or prevent such unpredictable flight, rockets to be destroyed should be pointed toward the enemy, or pointed downward—preferably in a trench or depression. Unassembled rocket heads are not propulsive. The following methods, in order of preference, are considered the most satisfactory for demolition of rockets, rocket heads, and rocket motors to prevent enemy use.

a. Method No. 1—By Detonation.

(1) *General.* Packed and unpacked rockets, rocket heads, and rocket motors may be destroyed by placing them in piles and detonating them with TNT, composition C or other explosive of equivalent potential.

(2) *Method of demolition.*

(a) More complete demolition will be accomplished if the rockets, rocket heads, and rocket motors are removed from their packings and piled—preferably in a trench or depression. One hundred pounds of packed rockets, rocket heads, or rocket motors require 1 pound of explosive to insure complete detonation. Unpacked rockets require approximately one-half pound of TNT per 100 pounds of rockets.

(b) Prepare the charge of EXPLOSIVE, TNT (using 1-lb or 1/2-lb blocks or equivalent together with the necessary detonating cord to make up each charge) and place the charge on the pile to be detonated.

(c) Provide for dual priming to minimize the possibility of a misfire. For priming, either a nonelectric blasting cap crimped to at least 5 feet of safety fuse or time blasting fuse (safety fuse burns at the rate of 1 foot in approximately 40 seconds and time blasting fuse burns at the rate of 1 foot in 30 to 45 seconds; test before using) or an electric blasting cap and firing wire may be used. Safety fuse and time blasting fuse both of which contain black powder, and blasting caps must be protected from moisture at all times. Safety fuse and time blasting fuse may be ignited by a fuse lighter or an ordinary match; the electric blasting cap requires a blasting machine or equivalent source of electricity.

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Caution: Blasting caps, detonating cord, safety fuse, and time blasting fuse must be kept separated from the charges until required for use.

Note. For the successful execution of methods of demolition involving the use of demolition materials, all personnel concerned will be thoroughly familiar with the provisions of FM 5-25. Training and careful planning are essential.

b. Method No. 2—By Burning.

(1) *General.* This method is limited to rocket heads packed without the rocket motor. Demolition of complete rockets and rocket motors by burning is not practicable since the first rocket or rocket motor taking off will disrupt the pile and cause the remaining units to take off in all directions.

(2) *Method of demolition.*

(a) Stack the rocket heads, either packed or unpacked, in piles. Place combustible material around and on top of the pile.

(b) Pour gasoline and oil over the entire pile.

(c) Ignite the pile by means of a paper or excelsior train and take cover.

Caution: Cover must be taken without delay since an early explosion of the rocket heads may be caused by the fire. Due consideration should be given to the highly flammable nature of gasoline and its vapor. Carelessness in its use may result in painful burns.

99. Demolition of VT Fuzes

a. In the event that it becomes necessary to destroy classified VT fuzes to prevent enemy capture, they will be given as high a priority in order of demolition as possible, for security reasons. If possible, their demolition should be so complete that there would be no residue of any fuze parts or pertinent literature that would be of any value to an enemy.

b. Unserviceable fuzes should be destroyed by one of the methods given below in order of preference.

(1) Remove cover from steel shipping box of fuzes. Take out one of the fuzes near the center of the box and insert a 1-pound block of TNT or nitrostarch and 5 feet of safety fuze with nonelectric blasting cap attached. Replace the fuze removed and detonate the explosive block. Electric detonation also may be used, in which case all boxes of fuzes should be prepared and detonated simultaneously. Suitable precaution must be taken to prevent injury to

personnel. Bangalore torpedo M1, shaped charge M2A3, or other suitable demolition equipment, can be used to advantage for destroying fuzes.

- (2) Individual cans of fuzes may be disposed of by dropping them in permanent bodies of water at location where water is over 150 fathoms deep and at least 10 miles from shore. Before disposal in this manner, all cans containing fuzes must be punctured.

c. All instruction cards, pamphlets, manuals, bulletins, ammunition data cards, and similar material should be torn into pieces, soaked in gasoline, and burned.

3. In the event that it becomes necessary to destroy classified VT fuses to prevent enemy capture, they will be given as high a priority in order of demolition as possible for security reasons. It is possible that demolition should be so complete that there would be no residue of any fuse parts or pertinent literature that would be of any value to an enemy.

4. Unserviceable fuses should be destroyed by one of the methods given below in order of preference.

- (1) Remove cover from steel shipping box of fuses. Take out one of the fuses near the center of the box and insert a 1-pound block of TNT or nitrostat and 5 feet of safety fuse with nondetonating blasting cap attached. Replace the fuse removed and detonate the explosive block. Effective detonation also may be used in which case all boxes of fuses should be prepared and detonated simultaneously. Suitable precautions must be taken to prevent injury to

APPENDIX REFERENCES

1. Publication Indexes

The following indexes should be consulted frequently for latest changes or revisions of references listed in this appendix and for new publications relating to materiel covered in this technical manual:

Index of Army Motion Pictures, Film Strips, Slides and Phono-Recordings. DA Pam 108-1

Military Publications:

Index of Administrative Publications... DA Pam 310-1

Index of Blank Forms..... DA Pam 310-2

Index of Graphic Training Aids and Devices. DA Pam 310-5

Index of Supply Manuals—Ordnance Corps. DA Pam 310-29

Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders. DA Pam 310-4

Index of Training Publications..... DA Pam 310-3

2. Supply Manuals

a. Supply Manuals Which Pertain to Ammunition Covered in this Manual.

Rockets and Rocket Ammunition..... SM 9-5-1340

b. Explosive Material Required for Destruction.

Explosives, Bulk Propellants, and Explosive Devices. SM 9-5-1375

c. General.

Introduction ORD 1

d. Maintenance and Repair.

Special Tools for Ordnance Explosive Disposal Munitions, Ammunition Renovating Tools, and Bomb Handling Tools. ORD 3 SNL J-11, Sec 2

Tool Set, Maintenance (Field), Ammunition Renovation Platoon. ORD 6 SNL J-8, Sec 4

Tool Set, Maintenance (Field), Explosive Ordnance Disposal Squad. ORD 6 SNL J-8, Sec 1

3. Other Publications

a. Ammunition, All Types.

Ammunition, General.....	TM 9-1900
Ammunition Renovation.....	TM 9-1905
Ammunition: Restricted or Suspended.....	TB 9-AMM 2
Artillery Ammunition.....	TM 9-1901
Ballistic Data, Performance of Ammunition...	TM 9-1907
Care, Handling, Preservation and Destruction of Ammunition.	TM 9-1903
Demolition Materials.....	TM 9-1946
Disposal of Supplies and Equipment: Am- munition.	SR 755-140-1
Explosives: Disposal by Dumping at Sea.....	SR 75-70-10
Identification of Inert Ammunition and Am- munition Components.	AR 385-65
Inspection of Ordnance Materiel in Hands of Troops.	TM 9-1100
Military Explosives.....	TM 9-1910
Ordnance Maintenance and General Supply in the Field.	FM 9-10
Qualification in Arms: Qualification and Fa- miliarization.	AR 370-5
Reports	SB 9-AMM 8
Safety: Coordination with Armed Services	SR 385-15-1
Explosives Safety Board—Report of Haz- ardous Conditions Involving Military Ex- plosives or Ammunition.	
Safety: Regulations for Firing Ammunition for Training, Target Practice, and Combat.	AR 385-63
Supply Control: Distribution of Ammunition for Training.	AR 710-1300-1

b. Launchers.

3.5-Inch Rocket Launchers M20 and M20B1..	TM 9-2002
Artillery Materiel and Associated Equipment..	TM 9-2300
Operation and Organizational Maintenance:	TM 9-3036
4.5-Inch Multiple Rocket Launcher M21....	

c. Camouflage.

Camouflage, Basic Principles.....	FM 5-20
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d. Decontamination.

Decontamination	TM 3-220
Defense Against CBR Attack.....	FM 21-40

e. Destruction To Prevent Enemy Use.

Explosives and Demolitions.....	FM 5-25
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f. General.

Ammunition: Supply Within the Continental United States. SB 9-AMM 6

Authorized Abbreviations----- AR 320-50

Dictionary of United States Army Terms---- SR 320-5-1

Logistics (General): Report of Malfunctions SR 700-45-6

and Accidents Involving Ammunition and Explosives (During Training or Combat).

Military Security: Safeguarding Defense Information. AR 380-5

Military Symbols----- FM 21-30

Military Training----- FM 21-5

Ordnance Ammunition Service in the Field--- FM 9-6

Ordnance Service in the Field----- FM 9-5

Protection of Ordnance General Supplies in Open Storage. TB ORD 379

Safety: Accident Reporting----- SR 385-10-40

Techniques of Military Instruction----- FM 21-6

g. Maintenance of Supplies and Equipment.

Spot Check Inspection and Reports; Ordnance Corps Materiel. AR 750-925

h. Shipment and Limited Storage.

Logistics (General): Report of Damaged or Improper Shipment. AR 700-58

Marking and Packing of Supplies and Equipment: Marking of Oversea Supply. SR 746-30-5

Packaging and Shipping of Materiel: Army Shipping Document. TM 38-705

4. Firing Tables and Range Tables

4.5-Inch Rockets, Expendable Launcher. Graphical Firing Tables M38 and M51.

Note. USAF operations analysts and gunnery officers may obtain aircraft gun firing tables and aircraft rocket firing tables by submission of requisition to the Commanding General, Aberdeen Proving Ground, Md., ATTN: Ballistic Research Laboratory.

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[AG 471.94 (7 Nov 57)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

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Ord Gp	Ord Proc Dist
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NG: State AG; units—same as Active Army.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

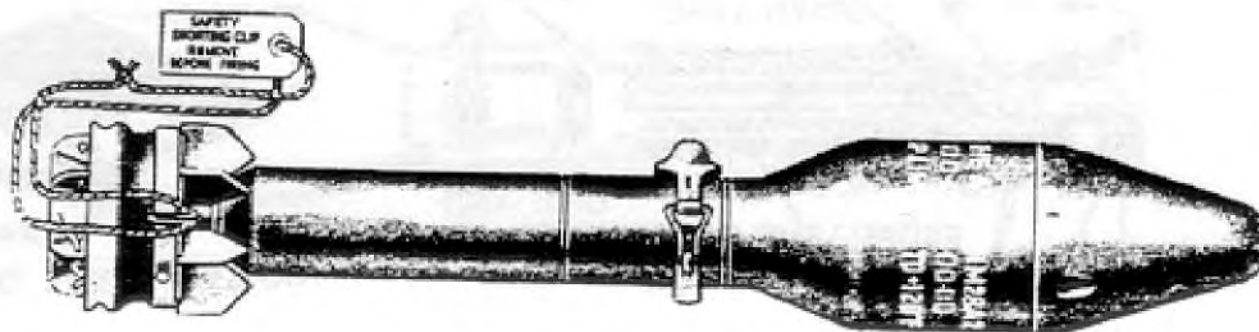
DEPARTMENT OF THE ARMY TECHNICAL MANUAL
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ROCKETS

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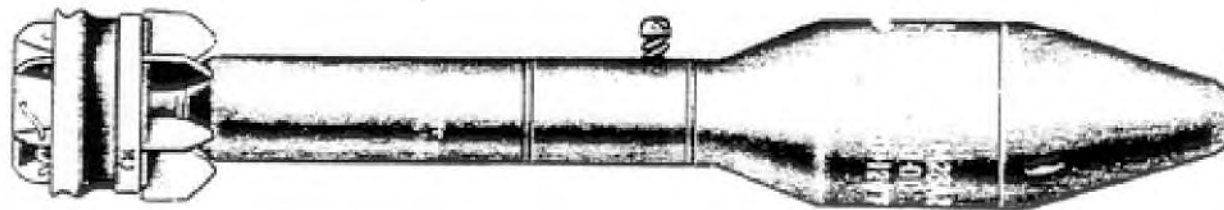
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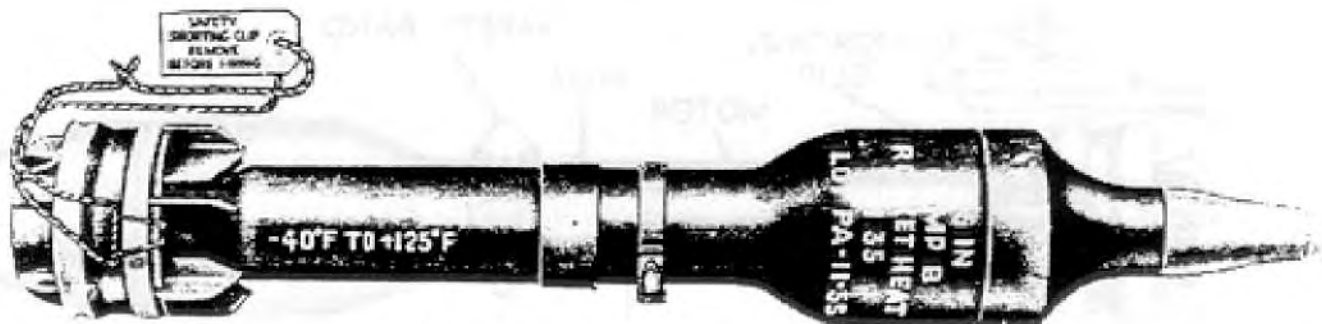
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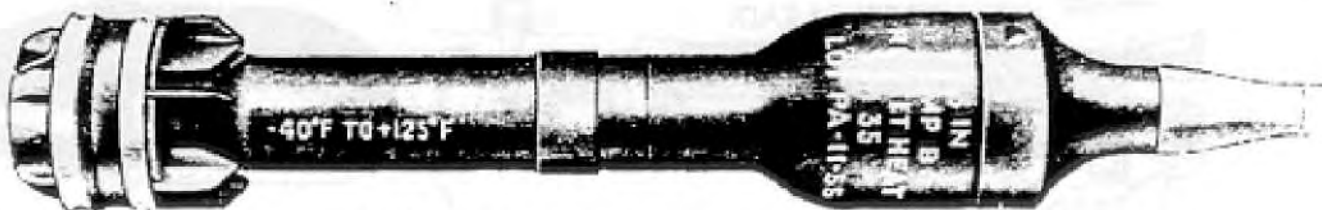
A-ROCKET M28A2, AS PACKED



B-ROCKET M28A2, AS FIRED



C-ROCKET M35, AS PACKED



D-ROCKET M35, AS FIRED

ORD D228

Figure 12. (Superseded) 3.5-inch rockets (as fired and packed).

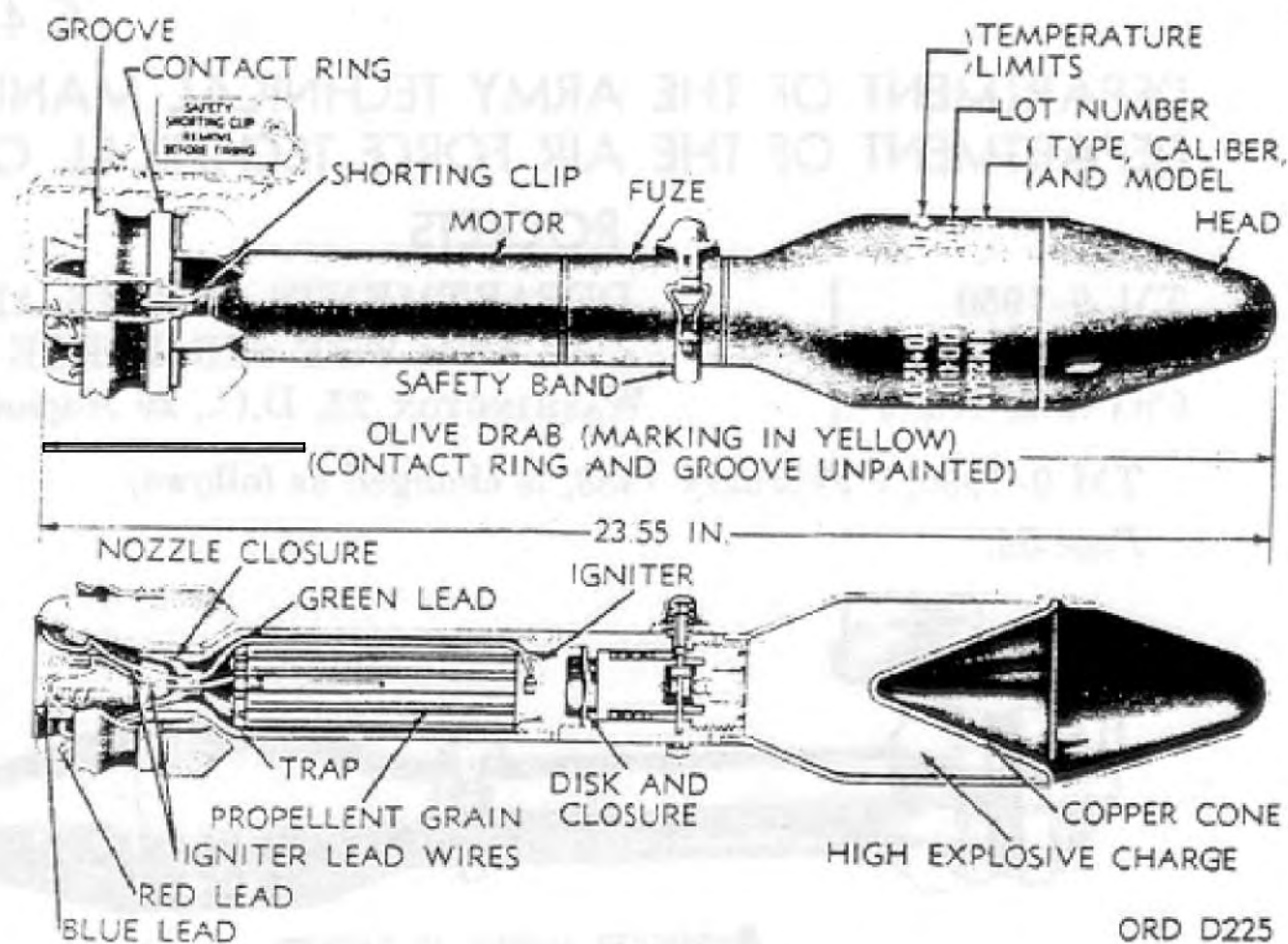


Figure 14. (Superseded) Rocket, high explosive, 3.5-inch: AT, M28A2.

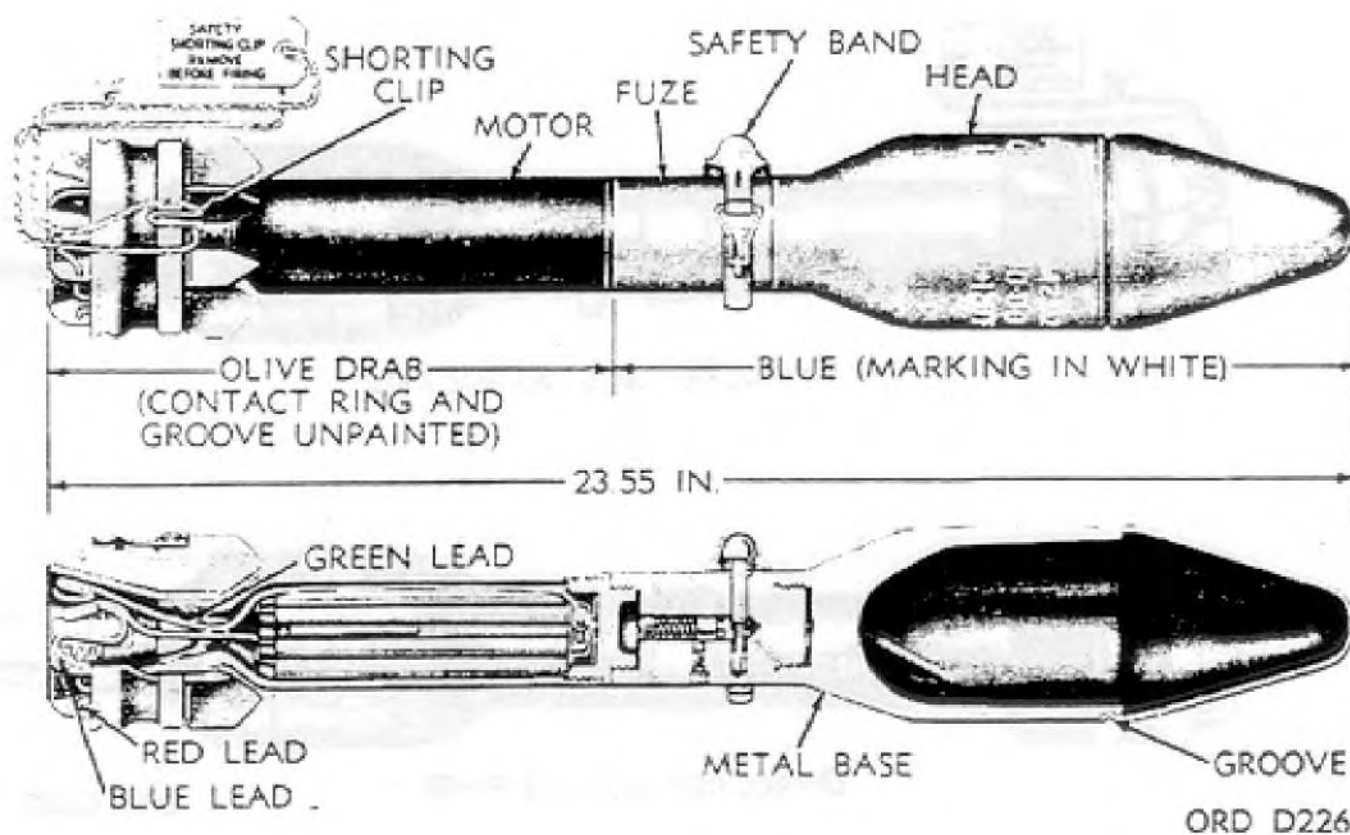


Figure 16. (Superseded) Rocket, practice, 3.5-inch: M29A2.

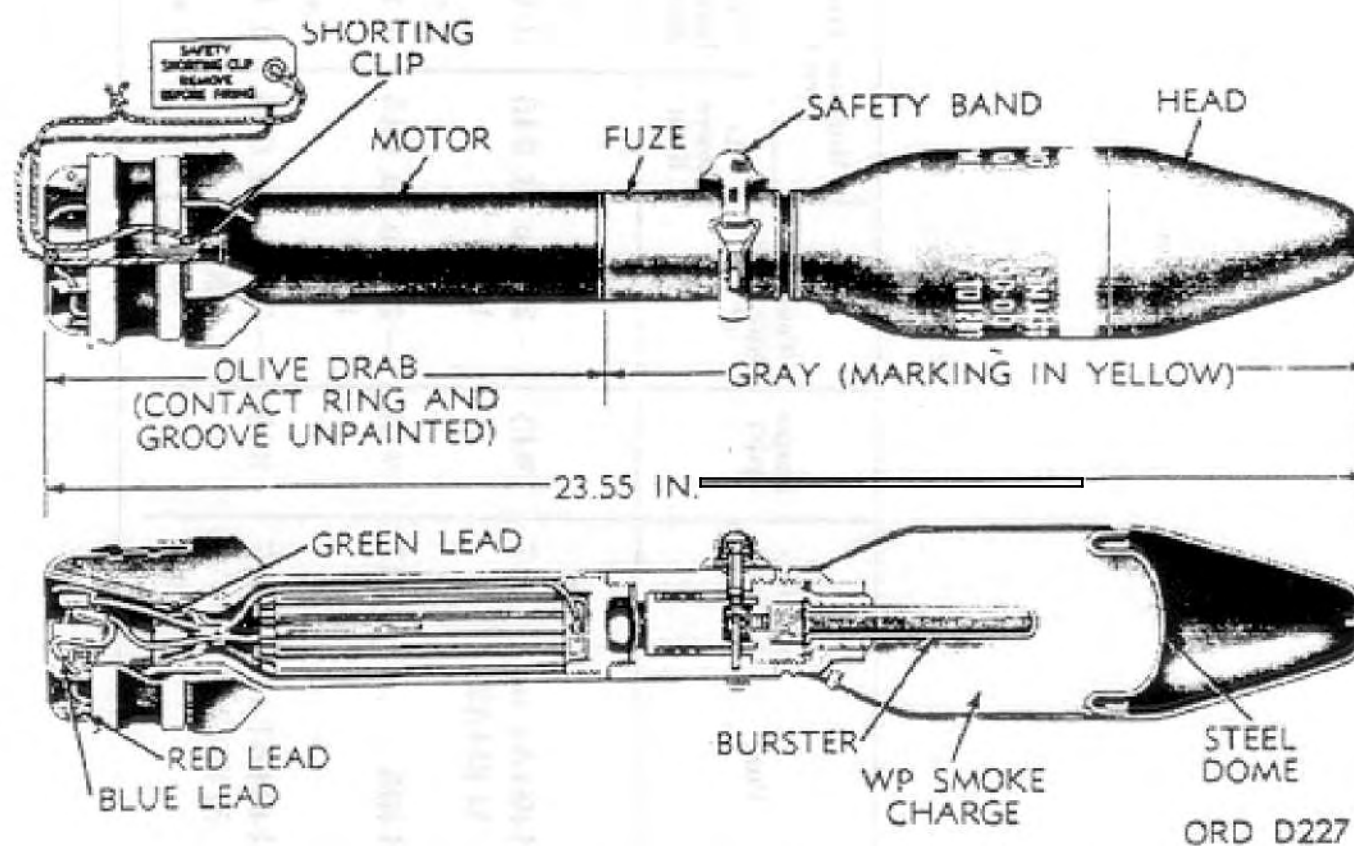


Figure 18. (Superseded) Rocket, smoke, 3.5-inch: WP, M30 (T127E3).

Table I. 3.5-Inch Rocket Data

Rocket nomenclature	Length (in.)	Weight (lb)	Head filler		Weight of pro- pellant (lb)	Fuze	Velo- city (fps)	Range (yds)	Tempera- ture limits (° F.)	Burning Time (sec)	
			Type	Weight (lb)						At lower limit	At higher limit
* Rocket, high-explosive, 3.5- inch: AT, M28A2.	* 23.6	9.02	Comp B	1.90	* 0.35	M404A1 or M404A2.	* 317	945	* -20 to 120. ¹	0.045	* 0.015
* Rocket, practice, 3.5-inch: M29A2.	* 23.6	8.96	Inert	Empty	* 0.35	M405	* 317	945	* -20 to 120. ¹	0.045	* 0.015
* Rocket, smoke, 3.5-inch: M30 (T127E3).	* 23.6	8.98	Smoke (WP)	2.23	* 0.35	M404A1 or M404A2.	* 317	945	* -20 to 120. ¹	0.045	* 0.015
* M30 (T127E3).	* 23.6	8.98	Smoke (WP)	2.23	* 0.35	M404A1 or M404A2.	* 317	945	* -20 to 120. ¹	0.045	* 0.015

¹ (Added) Rockets of older manufacture may have temperature limit markings of -30° F. to 120° F.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR
FORCE:

G. H. DECKER,
General, United States Army,
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For explanation of abbreviations used, see AR 320-50.

TM 9-1950
* C 5

TECHNICAL MANUAL

ROCKETS

TM 9-1950 } HEADQUARTERS,
CHANGE No. 5 } DEPARTMENT OF THE ARMY
WASHINGTON, D. C., 1 October 1963

TM 9-1950, 7 February 1958, is changed as follows:

6. Identification

e. *Marking.* Ammunition items are * * * the rocket motor. In some cases temperature limits are shown on the launcher and/or shipping containers.

9. Fuze

d. (As changed by C 1, 11 Mar 59) The PIBD fuze * * * with the target. One type of PIBD fuze used on rockets consists of a nose assembly and a base assembly connected by a wire passing through a conduit in the rocket head. The pressure * * * functions the fuze.

11. Launchers

f. (Superseded) *Expendable Launchers.*

(1) *66-mm Rocket Launcher M72.* The rocket launcher is a tubular, telescoping, smooth bore, single-shot, expendable weapon. The launcher serves as the carrying case, provides the initial flight direction, and fires the rocket. The launcher consists of an aluminum inner (rear) tube, a plastic impregnated glass outer (front) tube, a sling assembly, and controls and sighting equipment. In order to fire the weapon it is necessary to remove the sling assembly, extend the launcher, pull out the safety pin, unlock the trigger, and squeeze the trigger spring boot. For more information pertaining to this launcher refer to TM 9-1340-214-10.

(2) *4.5-Inch Rocket Launcher M12-series.* The 4.5-inch rocket launcher M-12 series consists of a plastic or metal alloy tube

* This change supersedes C 2, 21 November 1960, and C 3, 2 March 1961.

in which the rocket and fuze are shipped, and a light adjustable tripod mount. Sights and mounting clamps are assembled to the launcher as shipped, and accessories such as spades, batteries, and reels of wire, are packed in the launcher. In using this launcher, the covers are removed and the rocket is fuze. The tripod is then set up and adjusted and the launcher mounted and aimed. The lead wires are unreeled to reach a safe firing position and the rocket fired by means of a battery or magneto-type firing device.

12. Inspection of Rockets Prior to Use

(As superseded by C 2, 21 Nov 60)

With rockets unpacked, perform the following inspections prior to use:

a. Make certain that safety devices, such as safety wires, safety pins, short-circuit devices (shorting strips or clips, and the like) are in place.

b. All 3.5-inch HEAT rockets M28-series, WP smoke rockets T127E2, and WP smoke rockets M30 (T127E3) should be examined for loose heads. Grasp the fuze with one hand and attempt to twist the rocket head with the other. Examine for a discernible 360° gap between the head and the fuze.

Warning: Any round in which the head moves with respect to the fuze or has a discernable 360° gap between the head and the fuze is not to be fired. Any rocket evidencing either of the above conditions will be returned to segregated ammunition storage in a properly marked container indicating the condition.

c. Examine motors for serious dents or deformation and check straightness of fins.

d. Check that motor sealing disks and caps are securely in place. Loose disks should be replaced and the rocket used if it can be ascertained that moisture or other foreign matter has not entered the motor.

e. Examine components for corrosion, dirt, grease, or other foreign material, with particular attention to electrical contacts (fig. 5), threads, and fuze seats.

f. Ascertain that the temperature range, marked on the rocket or launcher, is not being exceeded at the time of use.

g. Check for exudation; high explosive heads may be cleaned and used.

Warning: Rockets with leaking chemical heads or exuding motors will not be fired but will be returned to segregated ammunition storage in a properly marked container indicating the condition.

15. Precautions in Storage, Handling and Use

* * * * *

b. *Handling and Use.*

* * * * *

(7) The danger areas * * * materiel before firing.

Warning: (page 1 of C 3; superseded) Eye protection in the form of goggles with safety glass lenses is mandatory for operating personnel at temperatures of 70°F. and above when firing 3.5-inch rockets. At temperatures below 70°F., 3.5-inch rockets of M28 (HEAT) and M29 (PRACTICE) series and rockets T127E2 and M30 (SMOKE) may be expected to produce blowback of propellant particles after projection from the launcher. Therefore, at temperatures below 70°F., face and hand protection is mandatory for all operating personnel. Field protective mask M9A1 will be used for face protection; other types of face protection are not authorized. All field protective masks M9A1 used for these rocket firings must be distinctively identified by attaching DA Form 10-197 or comparable blank tag to the head harness. One side of the tag will be marked in pen with the stock number and nomenclature of the mask while the reverse side will be marked in pen with the following: "Used in rocket launcher firing; prior to CBR use, inspect in accordance with SB 3-30-10 and repair as necessary." The identification tag will be removed at the time of inspection, only if the mask is acceptable for CBR use. Serviceability of masks, when used for rocket firings, should be based solely on considerations of vision and facial protection afforded and sanitation.

* * *
c. (As changed by C 3, 2 Mar 61) *Freezing Weather Use.* Rockets will function * * * limits marked thereon. Observe the **Warning** contained in b. (7) above relative to face and hand protection at temperatures below 70°F. Precautions (2), (3), and (4) below should * * * within the motor.

16. Misfires, Hangfires, Cook-Offs, and Duds

* * *
d. *Unloading an Unfired Round.*

(2) (As superseded by C 2, 21 Nov 60) *Before removal of the round.* Definite intervals, for waiting after a failure to fire and after additional attempts to fire, have been established on the basis of experience and characteristics of the launcher and ammunition as follows:

Warning No. 1: After a failure to fire, actuate the firing switch two additional times in attempts to fire. If the rocket launcher still fails to fire, wait 15 seconds from the last attempt to fire, then check the electrical circuit for

breaks, shorts, and poor contacts before another attempt to fire. If it is necessary to rotate 3.5-inch rockets M28-series, T127E2, or M30 (T127E3) within the launcher tube to insure electrical contact, rotate in a clockwise direction only, viewed from the rear of the launcher, to eliminate the possibility of unscrewing the head of the rocket from the fuze. After making any necessary adjustments, again actuate the firing switch three times. If the launcher still fails to fire, wait 15 seconds before removing the round, which is to be considered at fault unless subsequent examination reveals a defect in electrical circuits not previously detected.

Warning No. 2: If a slight noise is heard and a small puff of smoke is emitted from the rear of the launcher during an attempt to fire, this indicates that the igniter has functioned but has failed to initiate the propellant. If this is the case, it is mandatory to keep the launcher trained on the target and to observe all the precautions for firing for a 2 minute interval. At the end of this 2 minute interval, remove the rocket and return it to segregated ammunition storage in a properly marked container indicating the condition.

* * * * *

d. 1 (Added) *Disposal of an Unfired 66-mm Light Antitank Weapon.*

Note. The following procedure will be followed under training conditions only. Under combat conditions disposal will be made of the weapon after one failure to fire.

After failure to fire, due to the possibility of a misfire or a hangfire, the following warning will be observed until disposal is made of the weapon.

Warning: After a failure to fire, allow a precautionary waiting period of at least 1 minute before attempting to recock the weapon. During this interval the weapon will be kept trained on the target. After 1 minute, return the trigger safety handle to the safe position. Replace the safety pin in the firing pin housing, squeeze the detent boot, push the inner (rear) tube forward, and close the weapon at least one inch. Pull the recocking latch rod handle forward until it stops and release it. Grasp the bail handle and re-extend the rocket launcher to the extended (locked) position. Withdraw the safety pin. During all this time the weapon must remain as near the on-target position as possible. Next the weapon must be reaimed and the trigger safety handle pulled forward to the released position. Again squeeze the trigger boot. If the weapon still does not fire, it must be kept trained on the target for at least 1

minute. At the end of this one minute interval, return the trigger safety handle to the safe position, replace safety pin in the firing pin housing, and place the weapon system in a segregated location for disposition by Ordnance Ammunition Personnel in accordance with the provisions of TM 9-1903.

17. Packing

Ground rockets are * * * in wooden boxes. Exceptions are the 66-mm rocket M72 and 4.5-inch rockets M20 and M21-series, which are packed in their expendable launcher. Aircraft rockets * * * Department of the Army Supply Manual 9-5-1340.

18. General

These rockets (fig. 12) of * * * and motor assembly.

h. *Precautions in Firing.* General firing precautions * * * to 3.5-inch rockets:

(2) *Rockets M28, M28A2, M29A1, M29A2, and M30 (T127E3).*

(a) (Superseded) Since the rocket may burn for a time after projection from the launcher thereby placing the operating personnel in the "backblast" areas (fig. 9), eye protection in the form of goggles with safety glass lenses is mandatory at temperatures of 70°F. and above.

(b) (As superseded by C 3, 2 Mar 61) At temperatures below 70°F., these rockets may be expected to produce blowback of propellant particles after projection from the launcher. Therefore, at temperatures below 70°F., face and hand protection is mandatory for all operating personnel. Field protective mask M9A1 will be used for face protection; other types of face protection are not authorized. All field protective masks M9A1 used for these rocket firings must be distinctively identified by attaching DA Form 10-197 or comparable blank tag to the head harness. One side of the tag will be marked in pen with the stock number and nomenclature of the mask while the reverse side will be marked in pen with the following: "Used in rocket launcher firing; prior to CBR use, inspect in accordance with SB 3-30-10 and repair as necessary." The identification tag will be removed at the time of inspection, only if the mask is acceptable for CBR use. Serviceability of masks, when used for rocket firings, should be based solely on considerations of vision and facial protection afforded and sanitation.

i. *Preparation for Firing.*

(2) *Rockets M28, M28A2, M29A1, M29A2, T127E2, and M30 (T127E3).*

(a) (As superseded by C 2, 21 Nov 60) Remove from packing and inspect for serviceability as indicated in paragraph 12 as applicable. Should it be necessary to test for continuity, test with the circuit continuity tester.

* * * * *

Section I.1. 66-MM ROCKETS (FOR SELF-CONTAINED EXPENDABLE LAUNCHER)

28.1 General

a. *General Discussion.* The 66-mm rocket (fig. 19.1) of the fin stabilized type, is fired from either shoulder in a standing, kneeling, sitting, or prone position with the expendable launcher M72 (fig. 19.2). The rocket burns completely within the launcher at all operating temperatures. The high-exposive rocket M72 is used against armored targets. The complete weapon system consists of the launcher, warhead, fuze, and rocket motor which contains the propellant, primer, igniter, and fins.

b. *Warhead.* In external contour, the warhead M18 is cylindrical with tapered forward and rear portions. A closure is soldered to the rear portion of the warhead and the forward portion which tapers to a blunt portion, contains three evenly spaced detents around the circumference. These detents engage the three lugs of the nose cap for securing the cap to the warhead. The closure, which contains the fuze is internally threaded at the rear for assembly of the rocket motor.

c. *Fuze.* The PIBD fuze M412, a point-initiating base-detonating type, is electrically initiated, incorporating a graze functioning element. Electrical energy required to initiate the fuze is developed by a piezo-electric element ("lucky") located in the warhead nose. Upon contacting the target the "lucky" generates an electrical current which is carried by two leads to the electric detonator in the fuze. See paragraphs 41 through 51 for fuze description.

d. *Motor Assembly.* The motor assembly M54 consists of a cylindrical aluminum tube with external threads at the forward end for assembly to the closure and formed into a cone-shaped nozzle at the rear end. Six equally-spaced spring-actuated fins are located at the nozzle end of the motor body. The motor assembly contains the charge assembly (propellant) and rocket motor integral igniter. The primer block with percussion primer is assembled in a cavity at the rear of the rear tube.

(1) *Charge assembly (propellant).* The charge assembly (propellant) consists of 19 monoperforated cylindrical extruded grains of solvent propellant M7. The propellant grains are assembled lengthwise in a stud plate which is located at the

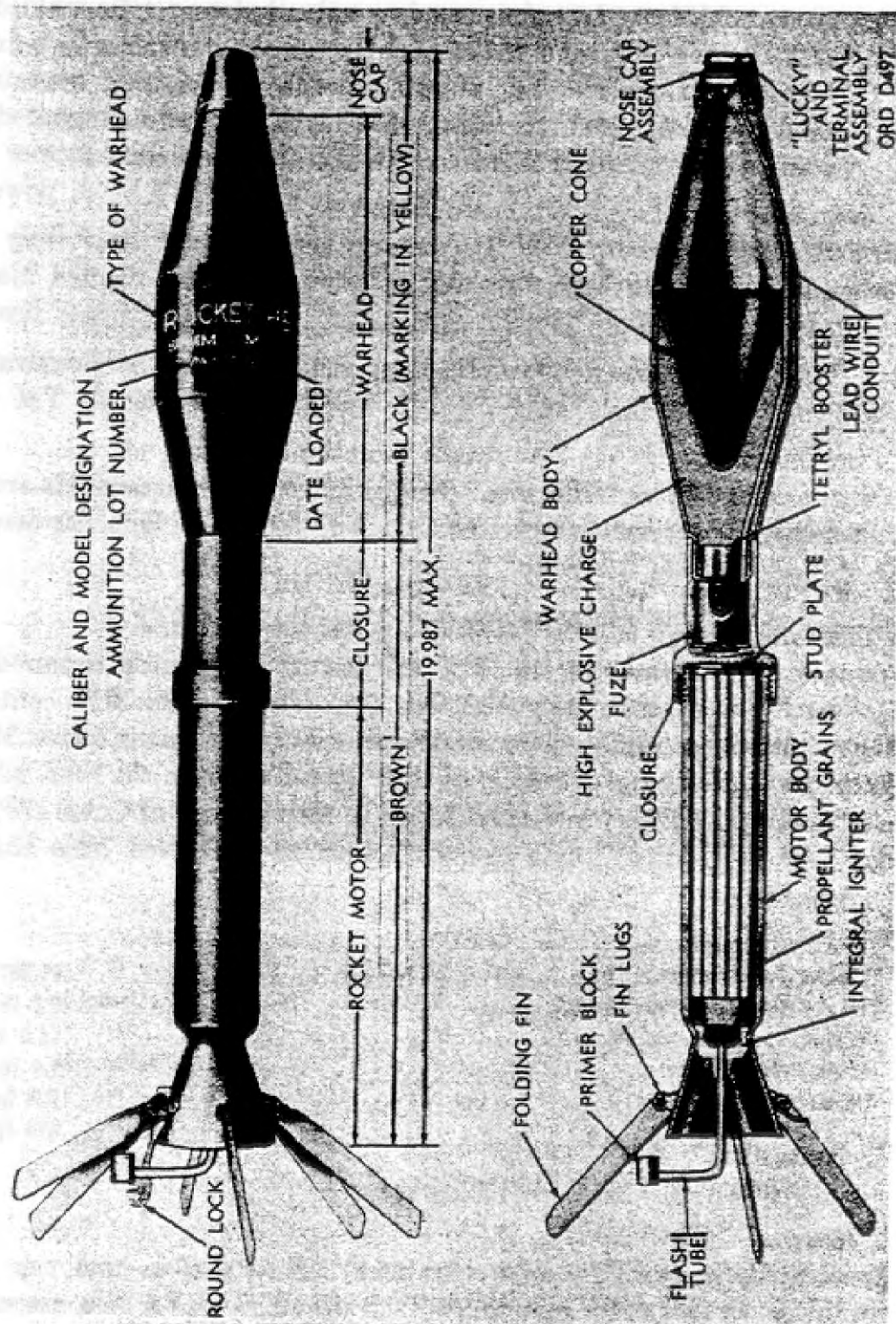


Figure 19.1. (Added) 66-mm High-Explosive Antitank Rocket M72.

forward end. Each grain is 5.78 inches long and 0.23 inch diameter.

- (2) *Rocket motor integral igniter.* The rocket motor integral igniter M56 consists of a one-piece polyethylene plastic molded igniter body containing 1.6 grams Grade A4 black powder, a flash tube 2.23 inches long and 0.175 inch in diameter containing an ignition transmission line of black powder impregnated cotton, and a primer block containing the percussion primer M29A1 which contains 60 milligrams of Grade A5 black powder.

e. Identification. The rockets are identified by their long tapered ogives and spring-actuated fins. The warheads are painted black with markings in yellow and the motors and closures are painted brown.

f. Preparation for Firing. The rockets require no preparation for firing. For firing instructions on the launcher, refer to TM 9-1340-214-10.

g. Packing and Shipping. Five rocket launcher assemblies are packed in a fiberboard container with three (fifteen rocket launcher assemblies) containers per wirebound wooden box.

28.2 Rocket, High-Explosive, 66-mm: AT, M72

a. This rocket (fig. 19.1) is intended for use against armored targets. The rocket M72 consists of the HE, AT warhead M18 containing a PIBD fuze M412-series within the closure and a rocket motor M54. The warhead contains a copper cone, whose apex is to the rear, which acts to shape the high-explosive charge of 0.666 pound of Octol (70% HMX and 30% TNT). The penetration effect is derived from the shaped charge.

b. Data.

Length (complete round) (fins closed)	19.987 inches
Weight (complete round)	2.3 lb (approx.)
Length (warhead w/fuze)	11.5 inches
Weight (warhead w/fuze)	1.2 lb
Range (maximum)	325 meters
Muzzle velocity (at 70°F.)	479 fps

47.1 Fuze, PIBD: M412-series (Added)

a. General. This fuze (fig. 25.1) consists of a nose cap assembly crimped to the forward end of the warhead, and a base assembly contained in the closure at the rear end of the warhead. The fuze is designed to function by either impact or graze. The impact action of the fuze is derived from the piezoelectric element which is contained in the nose cap assembly. When the piezoelectric element is crushed, a very small amount of electrical energy is developed and transmitted through the lead wire to the fuze. For graze functioning of the fuze, a spring-loaded



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Figure 102. (Added) 66-mm Rocket Launcher M72.

firing pin is released by the decelerating force of graze impact. The fuze is drop-safe and boresafe and arms after approximately 30 feet of rocket travel.

b. Description. The nose cap assembly is connected to the base assembly (fuze) by an insulated wire passing through a brass conduit in the warhead. The nose cap assembly consists of an aluminum cone containing the "lucky" (piezoelectric) element. The front face of the element is grounded to the body of the warhead through the aluminum cone and the rear face is connected to a detonator in the base assembly. The base assembly (fuze) consists of a body containing a rotor assembly, an escapement assembly, a spring-loaded firing pin, a stab primer T96, an electric detonator M48, and a tetryl-loaded booster cup.

c. Functioning. The fuze is free to arm when acceleration force accompanying the firing of the rocket has acted on the fuze. This force causes release of the escapement leaves and allows the rotor assembly to rotate into the armed position. The minimum arming distance is approximately 30 feet of rocket travel. The spring-loaded firing pin which is released by the decelerating force of impact allows for graze functioning of the fuze. The firing pin fires the stab primer which initiates the electric detonator which in turn, fires the booster charge.

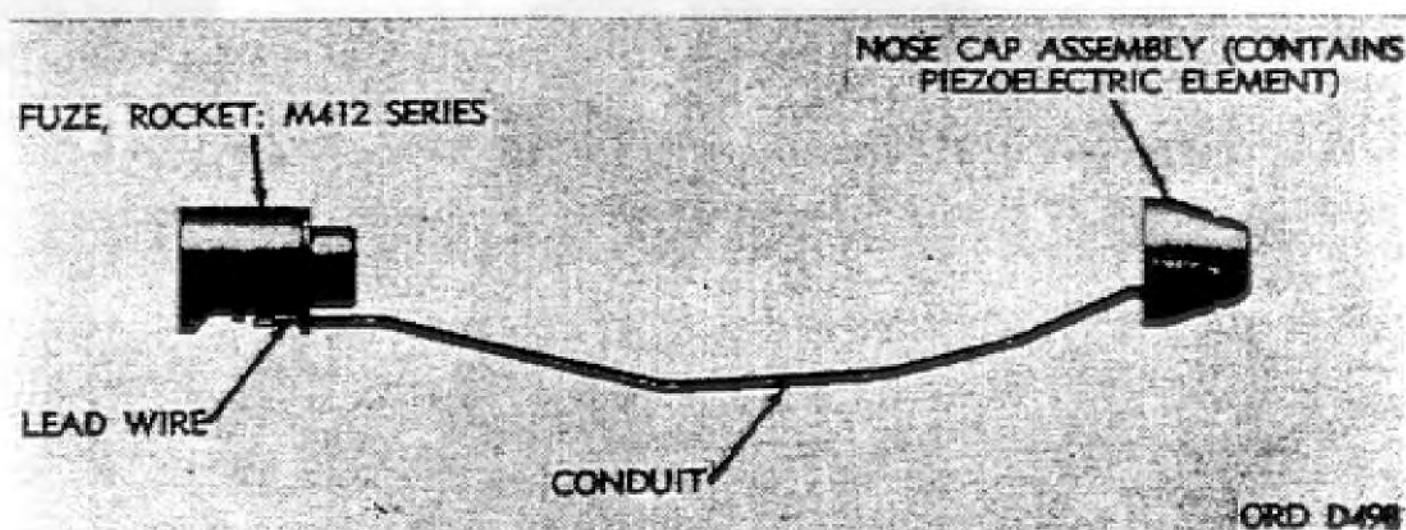


Figure 25.1. (Added) Fuze, point-initiating base-detonating: M412-series.

Page 97. Table II, (As changed by C 1, 11 Mar 59) change the model number in column 2, line 6, from MK1 to M1.

84. Fuze, Rocket: PI, M406

(As superseded by C 1, 11 Mar 59)

The fuze, which is externally threaded at the base to engage the 2.75-inch rocket head M1, is a mechanical PI type. The fuze is a fast acting, point initiated, spit back device with detonator safety and delayed arming features.

93.1 Propellant for 66-mm Rocket (Added)

Propellant for the 66-mm rocket is of the solvent extruded type M7. It is in the form of 19 single perforated cylindrical grains supported in a stud plate at the head end of the motor. The propellant, of the neutral burning type, burns in relatively short time and is completely consumed at all operating temperatures, while the rocket is in the launcher. See table V for data.

Table V. Rocket Propellant Data

Caliber of rocket	Propellant composition or model of grain	Type of composition	Type of grain	Grains per rocket	Weight of propellant (lbs)	Grain length (in.)	Grain outside diameter (in.)	Web (in.)
* (Added)	* M7	* Solvent	* Single perforated.	* 19	0.13	* 5.78	0.23	* 0.035
*	*	*	*	*		*		*

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

USASA (2)	Ord Bn (2)
DCSLOG (1)	Ord Co (2)
CNGB (1)	Instl (2)
CofEngrs (2)	Svc Colleges (2)
CofT (1)	Br Svc Sch (2)
USA CD Agcy (2)	Army Dep (2)
USCONARC (3)	GENDEP (OS) (2)
USAMC (2)	Ord Sec, GENDEP (5)
USAWECOM (2)	Ord Dep (OS) (5)
USAMUCOM (2)	PG (1)
USAMICOM (2)	Ord Arsenals (2)
USASMCOM (2)	Proc Dist (3) except
USACDC (2)	Chicago (None)
ARADCOM (2)	USA Ammo Proc & Sup
ARADCOM Rgn (2)	Agcy (1)
OS Maj Comd (2)	Fld Comd, DASA (2)
except USAREUR (5)	USA Tml Comd (2)
OS Base Comd (2)	POE (2)
LOGCOMD (2)	USAOSA (2)
MDW (1)	PMS Sr Div Ord Units (1)
Armies (3)	Mil Msn (1)
Corps (2)	MAAG (2)
USA Corps (2)	JBUSMC (2)
Div (2)	Units org under fol TOE:
Ord Gp (2)	9-500 (BB,IA,KA-KC) (2)

NG: State AG (3); units—same as active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see AR 320-50.

TM 9-1950

*C 7

CHANGE

No. 7

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 January 1966

ROCKETS

TM 9-1950, 7 February 1958, is changed as follows:

Page 18.

13. Testing Circuit Continuity of Rockets

(Superseded)

Note. Ignition Circuit Tester: (Allegany Instrument Co., Inc., Model 101-5BF) (4925-712-0205) or (Simpson Electric Co., Model ITS) (4925-712-0205) is recommended for this test.

a. Model 101-5BF.

Note. The key numbers shown below in parentheses refer to figure 6.

(1) Precautions.

(a) The testing area must be free from all sources of electricity which might ignite the rocket, except that from the test equipment.

(b) Place the rocket behind barricades able to withstand the full thrust of the rocket motor, and in a clamping device capable of preventing its flight in the event of ignition. A means of dissipating hot gasses from the test bay must also be provided.

(c) Under no condition should the tester leads be connected to the tester binding posts until the connection to the rocket is completed and the barricaded area cleared of personnel.

(2) Calibration of Allegany ignition circuit tester Model 101-5BF.

(a) Connect the 1-ohm resistor (7) to the tester binding posts (1).

(b) Set the dial (10) at zero by means of the zero adjust screw (2).

(c) Set the "OHMS ADD" knob (5) and the "OHMS" counter (9) to zero.

(d) Depress the key (8), adjust the "OHMS" counter to zero, and release the key. If an "OHMS" counter reading other than 1 ± 0.04 ohms is obtained, the tester must be repaired or replaced before proceeding with the ignition test.

*This change supersedes C 6, 26 November 1963.

(3) *Resistance test for test leads (5).*

Note. The tests leads are provided with the Simpson Igniter Tester Model ITS.

- (a) Attach the pin end of the one lead (5) to the tester's left-hand binding post (1) and the pin end to the other lead (5) to the tester's right-hand binding post (1) and short the remaining free ends by clipping their alligator clips to each other.
- (b) Depress the key (8), and adjust the ohms controls (6) until the meter pointer (9) is centered (at the null point). Release the key and read the resistance directly from the settings of the ohms controls.
- (c) Unclip the two leads from each other and remove the leads (5) from the tester binding posts (1).

(4) *Ignition resistance test.*

(a) Connection of tester to rocket. Refer to a(4) (a) above.

(b) *Igniter continuity test.*

1. Check to make sure that the barricaded area is clear of personnel.
2. Check to see that the meter pointer (9) is at its null-point or center before any measurements are made with the test set. If the pointer is not centered turn the meter adjustment screw (7) located on the meter until this condition is obtained.
3. Depress the battery test button (4) to check the condition of the internal battery (3). If the pointer does not deflect into the battery O.K. region of the scale, the battery must be replaced immediately.

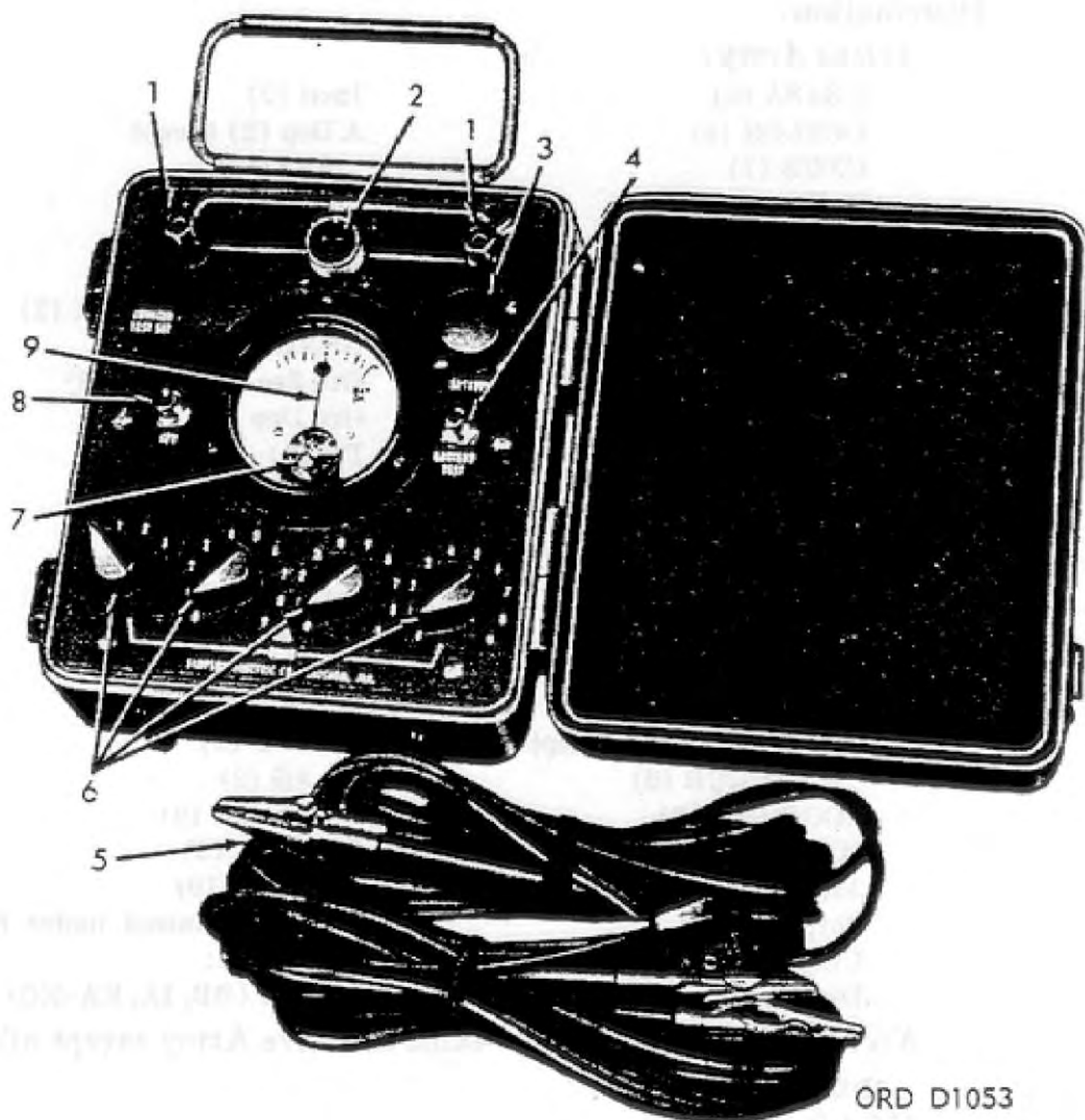
Warning: Do not attempt to make measurements with a weak battery.

4. Connect the igniter circuit under test to the input of the test set—either the binding posts (1) or the receptacle (2) may be used.
5. Set the ohms controls (6) to the approximate resistance expected.
6. Depress the key (8) and adjust the ohms controls until the pointer is centered. Read the resistance directly from the settings of the ohms controls. The controls (from left to right) are graduated as follows:
 - 1st—0 to 30 ohms, steps of 10 ohms.
 - 2d—0 to 9 ohms, steps of 1 ohms.
 - 3d—0 to .9 ohms, steps of .1 ohms.
 - 4th—0 to .09 ohms, steps of .01 ohms.
7. When the input is applied to the binding posts through test leads (5), the resistance of the leads must be subtracted from the value obtained in (6).

Note. In the case where a very low value of resistance is being measured, the pointer will react slowly because of the low resistance shunting of the meter. When this occurs, approximately 15 seconds should be allowed for the pointer to reach its final position after the ohms controls have been adjusted.

Caution: Do not make measurements with the tester in any circuit where voltage is present. This voltage could result in a reading error or damage to the tester.

8. Permissible range for 3.5-inch rockets is 0.7–1.75 ohms; for 2.75-inch rockets, 0.7–1.5 ohms. Reject any rocket which twice fails this test.
9. Disconnect the test leads from the rocket and replace the shorting device. (Be sure to disconnect the test leads from the tester binding posts before entering the barricaded area.)



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Figure 6.1. (Added) Simpson igniter test set Model ITS.

- | | |
|-----------------------|--------------------------|
| 1 Binding posts | 6 Ohms controls |
| 2 Receptacle | 7 Meter adjustment screw |
| 3 Battery (capped) | 8 Key |
| 4 Battery test button | 9 Meter pointer |
| 5 Test leads | |

TAGO 1091B

Page 20. Figure 7. Rescinded by C 6, 26 November 1963

Page 21. Figure 8. Rescinded by C 6, 26 November 1963

By Order of the Secretary of the Army:

Official:

J. C. LAMBERT,
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The Adjutant General.

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff.

Distribution:

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DCSLOG (1)
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USACDC (2)
USACDC Agcy (2)
USAMUCOM (2)
USAMICOM (2)
USASMC (2)
USATECOM (2)
USAAPSA (5)
USAMB (2)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (2) except
USAREUR (5)
LOGCOMD (2)
MDW (1)
Armies (3)
Corps (2)
USAC (2)
Div (2)

Instl (2)
A Dep (2) except
SVAD (5)
LEAD (5)
Sve Colleges (2)
Br Sve Sch (2)
PMS Sr Div Ord Unit (1)
GENDEP (2)
Ord Sec GENDEP (5)
Ord Dep (5)
PG (1)
Arsenals (4) except
Picatinny (51)
Proc. Dist (3) except
Chicago (none)
Fld Comd, DASA (1)
USA Tml Comd (2)
POE (2)
Mil Msn (1)
MAAG (2)
JUSMAGG (2)
JBUSMC (2)
USACSS (10)
United organized under following
TOE's:
9-500 (BB, IA, KA-KC) (2)

NG: State AG (3); units—same as active Army except allowance
is one copy.

USAR: None.

For explanation of abbreviations used, see AR 320-50.